(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL.

[Formerly the RAILROAD AND ENGINEERING JOURNAL.]

The AMERICAN RAILROAD JOURNAL and VAN NOSTRAND'S ENGINEERING MAGAZINE have been consolidated in this publication.

VOLUME LXIX.

[VOLUME IX, NEW SERIES.]

1895.

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M. N. FORNEY.

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THE OLDEST RAILROAD PAPER IN THE WORLD.

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NEW YORK, JANUARY, 1895.

AN EVERLASTING FALLACY.

PROBABLY few editors or publishers have ever launched their journalistic bark without entertaining the illusion that if they could induce each of their subscribers to send in a new one they would thus double their subscription lists. The plan is so simple, the reasoning is so sound, and the result so desirable, that it is hard to dismiss the idea entirely. Of course, there is the fatal *if*. In Hibernian phraseology, "to say it is easy, but to do it," or have it done, there is where the interrogation mark comes in. There is, of course, no impossibility in the way of any subscriber getting and sending a new one. In fact, to most of them it would probably be an easy task to undertake and accomplish. The lack of an adequate motive is the only obstacle in the way. Some excellent reasons can, however, be given why each and all of our subscribers should send us a new recruit. In the first place, the argument which one of our contemporaries—a hilarious chap—used in soliciting an advertisement from a stern railroad president, who replied interrogatively to the persuasion of the solicitor by asking sternly, "Why should I advertise in your paper? What good will it do me?" "Oh, it won't do you a —— bit of good," the solicitor replied, "but think of the good it will do me." To those of our subscribers who can see no advantage to them resulting from sending us a new one we reply, "But think of the good it will do us."

But to present the matter argumentatively: have our subscribers ever reflected seriously on the question, and is it quite certain that they would not be advantaged by increasing our list of subscribers and readers? To increase that list is to add to our sinews of war.

It was said of the celebrated Mr. Beecher that when he commenced his ministerial career in Indianapolis he was in the habit of saying so many things in the pulpit which made some of his congregation smile that finally a committee of his church officers was appointed to remonstrate with him thereon. "Oh," he replied, on hearing what their errand was, "if you gentlemen only knew the funny things which I *don't* say." Now, our readers don't know the good things which we don't publish, because they would cost too much. We don't know how much information we could get if the expense could be incurred of going or sending for it. Valuable contributions must be refused at times because of their cost. Illustrations must be omitted for the same reason. At present we have no geniuses on the staff of this paper; with a sufficient increase of revenue we would do our best to employ one or more.

Gentlemen subscribers—and ladies, if there are any—you would be greatly benefited by increasing our subscription list. Of course the satisfaction of doing a good deed and of working in a worthy cause would be yours, and you would be affected as the moon is by reflected light. Our brilliancy would be increased, which would illuminate you. Consider the matter, and if your inclinations, your self-interest, or your impulses prompt you to do so, secure for us one or more new subscribers for the year 1895; but whether you do or not, we take great pleasure in wishing you a HAPPY NEW YEAR.

M. N. FORNEY.

EDITORIAL NOTES.

THE attention of our readers is called to the large amount of aeronautical matter that is published in this issue. We found that the usual four pages that has been allotted to this department of the paper was insufficient to contain all of the interesting contributions that we have received, and therefore eight pages have been devoted to it. In order, however, that the space devoted to general engineering might not be curtailed, the size of the issue has been increased to 52 pages.

IT is not many years since it was firmly believed and openly preached that American manufacturers could not make ships, and even if they could, they could not make the armor to protect them. This position has been utterly destroyed, and no sooner has it been accomplished than we hear of them prospecting for foreign work, which has now been secured in an order that has just been given to the Bethlehem Iron Company for armor plate for Russian vessels. It attracts attention because we believe it is the first; but from the success that has been already achieved by this firm in the tests executed in this country, it is not likely to be the last.

THE Rules of Interchange, as formulated by the Master Car-Builders' Assoeiation, have been troubled waters in which to navigate the craft of the department for many years, and the Arbitration Committee has been busy in settling disputes that have arisen over the varied interpretations of the code. Every convention sees modifications introduced and much time devoted to the *pros* and *cons* of the discussion that this subject always starts and sustains. To the outsider and, indeed, to the participants, it seemed that there was no final solution probable until the roads centering in Chicago, tired of the delays and vexations that the application of the rules involve, have entered into an agreement to ignore them, and have formulated a little code of their own. To say that the whole country is watching and hoping for the success of the experiment is putting it mildly. It is rumored that the New England roads, encouraged by the example set in the West, are about to try the same methods of solving the problem. It would be passing strange if, after all the trials and tribulations

over the interchange rules of the past decade, they were to be at last settled by the simple process of cutting the Gordian knot.

THE ANNUAL MEETING OF THE MECHANICAL ENGINEERS.

The proceedings of the annual meetings of the American Society of Mechanical Engineers and other kindred associations have now become so voluminous that it is impossible for a monthly publication like the American Engineer to give even an intelligible abstract of the papers and discussions. All that can be done is to publish such papers as have special value, and, by way of comment, refer to others which shed any new light on questions which are of interest to us and our readers.

On another page the admirable paper by Professor Goss, with the title An Experimental Study of the Effect of the Counterbalance in Locomotive Driving-Wheels upon the Pressure between Wheel and Rail, is reprinted, with the discussion thereon. The latter, in which the writer took a part, will perhaps make any further comment here superfluous. There is an undoubted tendency among reformers to exaggerate evils which they undertake to reform. In that paper it was shown that the rear or trailing wheels of the experimental locomotive at the Perdue University, where the investigations were made, and which had 54.2 per cent. of excess of counterbalance, as determined by an average of five rules "in common use," lifted entirely clear of the rail at a speed of 58.3 miles per hour. The main driving-wheel, which had an excess of only 4 per cent., did not rise clear of the rail, and, from the diagrams in fig. 4, it would appear that the wire which was run under the wheels whose original diameter was 0.037 in. and the compression of which recorded the downward pressure of the wheels, was reduced at the point of minimum pressure to about 0.2375 in., showing that there was considerable downward pressure even at that point. This wheel had a total counterbalance of 550.2 lbs. It would be interesting to know to what extent the thickness of the wire would have been affected if the wheel had been counterbalanced by Rule B, referred to in the paper, which would have made the weight only 462 lbs. Locomotive engineers would like to know what the variation of pressure on the rail is when a locomotive is counterbalanced by any of the rules which give good results in practice. As was pointed out in the discussion, all that the paper proves is that an *excess* of counterbalance produces some bad effects which may be dangerous. This may be a good reason for being very careful that locomotives have not an excess of balance weights, but hardly justifies sensational statements of the injurious effects of such weights when they are most advantageously proportioned. There can be no doubt, though, of the fact that even in the latter case counterbalance weights produce very serious disturbances in locomotives when they are working at high speeds, and that it is very desirable to eliminate these disturbances if we can do so without incurring other evils more serious than the effects of such weights. The most successful effort which has thus far been made to do this is that of M. Baudry, Chief Engineer of Traction of the Paris, Lyons & Mediterranean Railway, one of whose engines was illustrated in the Railroad and Engineering Journal of November, 1892, page 499, and again in the American Engineer of June, 1893, pages 296–299, and in this number on page 31. A similar engine for the Northern Railway of France was illustrated in March, 1893, and one of them was exhibited at the Chicago Exhibition in the same year, and which did not seem to attract the attention from American engineers which its merits deserved. Mr. George S. Strong has designed an engine on similar lines, and efforts are now being made to introduce it in this country.

The French locomotives referred to are of the compound type, with four cylinders, four driving-wheels and a four-wheeled truck. The small or high-pressure cylinders are outside and connected to the rear or trailing pair of drivers. The large or low-pressure cylinders are inside the frames, and are connected to a cranked axle to which the forward or main driving-wheels are attached. The two cranks on each side of the engine are opposite to and balance each other. The two pairs of wheels are connected together by coupling-rods. From this description it will be seen that the rear or trailing pair of wheels are driven by the high-pressure cylinders, and the front pair by the low-pressure cylinders. Consequently each pair of these does only half the amount of work which the cylinders of a simple engine must do, and the only function of the coupling-rods is to hold the two pairs of wheels in their proper relative positions. Consequently all the parts may be and were made very light. Of course there is considerable duplication of parts, and there is the cranked axle and inside cylinders, which are great bugbears to Americans. The evil of the former, it is believed, however, is exaggerated here, and is not as great now, with the improved materials and methods of manufacture of the present day, as it was 40 years ago, the experience of which time with such axles some of us old fellows still remember. The evils of inside cylinders are also lessened by placing the valve-seats vertically and on the outer sides of the cylinders. This permits the steam-chests and their covers to be removed from the outside, and also makes the valve gear accessible, the high-pressure or outside cylinders being attached farther back on the frames than the low-pressure ones are, which permits of access to the valve faces of the latter from the outside.

Mr. Strong has worked in somewhat the same direction, but he connects both pairs of cylinders to the front driving-axle. Now, it seems as though, from a purely mechanical standpoint, that these are the most perfect forms of locomotives that have yet been designed. Whatever advantage there is in compounding ought to be realized in an engine of this type; and by locating the two cranks on each side opposite to each other the reciprocating parts of the one will balance those of the other. It is necessary, then, to balance only the revolving parts, which presents no difficulties.

It is to be hoped that Professor Goss will tell us, however, just what the effects of counterbalances are when they are proportioned in the most approved way, and indicate the consequent evils. It will then be a question for consideration whether these evils are greater or less than those of duplicate cylinders and their connections, and duplicate valve gear, a cranked axle and inside cylinders. Of course the French or the Strong engine must be credited with the saving due to the compound system if they are compared with simple engines; but there would be no such credit if they are compared with a two-cylinder compound locomotive. It is to be hoped that either Mr. Strong's or Mr. Baudry's locomotive will be tried under fair auspices in this country.

Besides Professor Goss's paper, there were some others which were interesting to railroad men. Mr. David L. Barnes presented one on Rail Pressures of Locomotive Driving-Wheels. This, with Professor Webb's appendix, which gives an Analysis of Path of Centre of Gravity of Driving-Wheel, fills 56 pages. The impression left after reading Mr. Barnes' paper is that the subject which he has discussed is a very complex one, and that he is very uncertain about his conclusions. Professor Webb's analysis to the ordinary reader appears like a sort of transcendental discussion of the subject, to be understanded only by those who can sustain mental existence in an ether of pure mathematics, and do not require an ordinary atmosphere for their intellectual sustentation. We have not been able to draw many practical deductions from either, although perhaps a more profound study of each might reveal their esoteric meaning.

Two other papers were read at the meeting which were interesting, but neither of them entirely fulfilled the promise of its title. One was by Mr. G. W. Bissell, of Ames, Ia., on The Effect of Clearance on the Economy of a Small Steam Engine. He took a small engine with a 4½ × 9 in. cylinder, and by retapping the holes for attaching indicator pipes and inserting therein pieces of 1-in. pipe of sufficient length, he increased and diminished what was practically the clearance space in the cylinder. The conclusions deduced from the experiments was "that the maximum economy at all loads is obtained with a clearance of about 14½ per cent. of clearance." This conclusion is important if true. The engine was a throttling slide-valve engine, the exhaust being condensed in a Wheeler surface condenser, operated by a small combined air and circulating pump. The question of most economical amount of clearance in engines involves a good many more elements than Mr. Bissell apparently took into account. The nature of the release of the steam, doubtless, would have an influence on the question. Thus, if the distribution of steam was effected by an ordinary link motion and slide-valve which at short points of cut-off docs not give a free release to the steam, and is always attended with much compression, doubtless more clearance would be needed than would be required if the release was effected by an independent valve, which would give a free release at all points of the stroke. Then, doubtless, too, the amount of clearance and the inside lap of a slide-valve would influence each other. It is probable, also, that the position of the exhaust ports, the condition of the inside surfaces of the cylinder, the speed and counterbalance of the engine, would all influence each other. If there was little cylinder condensation, and the exhaust ports were located at the bottom of the cylinder so as to drain it perfectly, and if the moving parts of an engine balanced each other, probably each of these elements would help to diminish the amount of clearance which would be most economical. It makes one's scientific fingers tingle to think of the interest and value which a series of experiments would have to determine these points, if one only had the time and opportunity.

Another paper was by Mr. John H. Barr, of Ithaca, N. Y., on Experiments on a System of Governing by Compression. The author starts with the assumption that "it has been known for a long time that a given engine with a given initial pressure, etc., operates with the lowest steam consumption per H.P. per hour at a certain point of cut-off, and that a variation of the point of cut-off either side of this point is accompanied by a higher rate of steam consumption." As Dr. Thurston pointed out as long ago as 1881, and as Mr. Charles T. Porter tried to show in a paper read at the last meeting, "it would seem," using Dr. Thurston's language, "that the ratio of expansion should be fixed at the best proportion for the steam pressure adopted, and never changed." To regulate the power developed, he and others, including the author of the paper referred to above, proposed to do so by increasing or diminishing the back pressure or compression. There is neither time nor space now to follow the investigations reported in the paper before us. The writer's conclusions were, from the limited experiments which he made, "that reducing the mean effective pressure by increasing the back pressure does materially reduce cylinder condensation, as we had been led to expect; but we did not secure a net saving in steam;" and, further, "while it is decidedly unsafe to draw conclusions from such limited data, these few trials indicate, as far as they go, that, whatever the possible gain from using compression as a method of governing may be, it will probably prove effective in ameliorating the wastes of the steam engine only to a limited degree under ordinary circumstances."

It is not easy, though, to foresee what the influence of such diverse causes, conditions and elements will have upon each other. In patent phraseology, what will be their effect in combination? This would be well worth knowing.

NEW PUBLICATIONS.

Poor's Directory of Railway Officials. Ninth Annual Number. Poor's Railroad Manual. 406 pp., 5⅝ × 8⅝ in.

Little need be said of this directory, excepting that it is more complete than ever, and that it is wonderfully convenient for all who have business or other dealing with railroad officials. It includes the officers of all railroads in North America and of the leading organizations auxiliary to the railway systems, lists of officers of South American and Hawaiian railways, etc.

Catechism of Car Painting. By Frederick S. Ball, Master Car Painter, Pennsylvania Railroad, Altoona, Pa. Reprinted from the Proceedings of the Master Car and Locomotive Painters' Association by the *Railroad Car Journal.* New York. 15 pp., 3¾ × 5¾ in.

In this little report the different methods and processes of painting a car are described, so that a person who is ignorant of the whole subject can get a very good idea of it in half an hour by reading the questions and answers. It will be found very useful, and could have been amplified with advantage to the reader.

Transition Curves. *A Field Book for Engineers, Containing Rules and Tables for Laying out Transition Curves.* By Walter G. Fox, C.E. Van Nostrand's Science Series. 80 pp., 3¾ × 5¾ in.; 50 cents.

The new field book for civil engineers, giving concise instructions for laying out transition curves, is an admirable compilation of text and tables. The work is practical as well as scientific. The tables of transition curves are new, and will be found very useful in practice. They will save more time in a day's work in the field than ten times their cost. Transition curves are not run in on the ground in the first located lines, but are a refinement to be introduced in the track alignment when the rails are being laid and finally adjusted for operating. The book is in convenient form, and will be easily carried in the pocket of the field engineer.

Accurate Tables of Diameters, Areas, Weights, etc., of Cold-Drawn Seamless Steel Tubing. By O. J. Edwards, Ellwood City, Pa. 10 pp., 5¼ × 6¼ in.

The Ellwood-Ivins Tube Company are manufacturers of high grade seamless tubing, they say, in all metals from $\frac{1}{64}$ in. to ¼ in. in diameter. Assumably the author is connected with this establishment, although it is not said so in his publication. He has published a series of tables which give the internal diameters, areas external and internal, area of cross section of metal, weight in pounds per foot and per inch of tubes varying from ¼ in. to 2¼ in. external diameter, and made of different thicknesses of material varying from .014 in. to .259 in. These tables are very conveniently arranged, and are well printed. A full explanation of each would have enabled the reader to understand them easier than he can without such explanations.

Pennsylvania Railroad Men's News. Issued monthly by the Pennsylvania Railroad Young Men's Christian Association, Philadelphia. 22 pp., 6⅝ × 9¼ in.

This little monthly comes to us resplendent in fine typography, engraving and coated paper. About one-half of the number before us is filled with an article on the Passenger Department of the Pennsylvania Railroad, with portraits of a large number of its principal officers. This suggests the inquiry, Why the fondness for having their pictures published which seems to be so characteristic of this department? Probably there are more portraits of passenger agents and other officers in that branch of railroad service published than of all others taken together. It must be that it is thought that their good looks will attract travel to their roads. The latter half of the number before us is also filled with good reading, and a very

attractive picture of the Young Men's Christian Association club house of the Pennsylvania Railroad in Philadelphia adorns the outside of the cover.

The weekly journal *Science* will be published after January 1 under the direction of an editorial committee in which each of the sciences is represented by a man of science who is at the head of his department. The committee is constituted as follows: Mathematics, Professor S. Newcomb (Johns Hopkins University and Washington); Mechanics, Professor R. S. Woodward (Columbia College); Physics, Professor T. C. Mendenhall (Worcester); Astronomy, Professor E. C. Pickering (Harvard University); Chemistry, Professor Ira Remsen (Johns Hopkins University); Geology, Professor J. Le Conte (University of California); Physiography, Professor W. M. Davis (Harvard University); Paleontology, Professor O. C. Marsh (Yale University); Zoölogy, Professor W. K. Brooks (Johns Hopkins University), Dr. C. Hart Merriam (Washington); Botany, Professor N. L. Britton (Columbia College); Physiology, Professor H. P. Bowditch (Harvard Uuiversity); Hygiene, Dr. J. S. Billings (Washington); Anthropology, Professor D. G. Brinton (University of Pennsylvania), Major J. W. Powell (Washington); Psychology, Professor Cattell (Columbia College). This committee assures a high scientific standard and wide field of usefulness to the journal.

Electric Lighting Plants, their Cost and Operation. Data Compiled from Station Reports of Electric Lighting Plants Employing Overhead Circuits, with Suggestions Pertaiuing to the Information Usually Desired by the Non-Technical Reader. By W. J. Buckley. Chicago: William Johnson Printing Company. 275 pp., $4\frac{3}{4} \times 7$ iu.; $2.

The author of this book says in his preface that he is "neither an electrician, engineer, nor expert, but a salesman, identified since 1885 with what is now the Fort Wayne Electric Corporation." In the little volume which he has brought out he treats engiueering questions from a purely commercial view. What does it cost and what will it pay are the two questions which are uppermost all through his book, which is written in the style in which an active, intelligent and loquacious commercial traveller would be likely to present his case. The purpose of what the author modestly calls a "pamphlet" is, he says, "to give intending purchasers of lighting plants such details as may aid them in forming a fair estimate of the cost of construction and operation of their proposed station." There are many hints given which doubtless will be useful to the class of readers for whom it is intended.

Proceedings of the Twenty-fifth Annual Convention of the Master Car and Locomotive Painters' Association, of the United States and Canada, held at Buffalo, N. Y., September 12–14, 1894. 43 pp., 7×10 in.

This Association issues its report in a well-printed volume of perhaps a rather unwieldy size, but generally its make-up is creditable. Besides the usual speeches and reports of officers, it gives reports on the following technical subjects: 1. What is the Best Method of Keeping Accounts in the Paint Shop? 2. What Methods and Materials Produce the Best Results in Repainting Passenger Cars? 3. Classification of Repairs to Passenger Cars; 4. an essay on the painting of passenger cars, in the form of questions and answers; 5. The Best Method of Computation and Establishing Rates for Piece-work; 6. The Prevention of Loss of Paint-Shop Tools; 7. Advantages of Using Ready Prepared Primers and Surfacers; 8. Formulas for Primers and Surfacers; 9. What Style of Finish in the Construction of Passenger Equipment Cars is most Desirable from a Painter's Standpoint. The discussions of most of these reports are given with more or less fulness. The volume ends with a list of members, but there is no index, which is inexcusable.

On the Covered Markets needed in Rome (Per i Mercati Coporti occorrente a Roma). By Marc Antonio Boldi. Rome: published by Centenari Brothers. 31 pp., 8×11 in., paper covers.

This pamphlet forms a supplement to Signor Boldi's very full work on covered markets noticed in these columns some months ago, which work he says was deficient upon two points, in consequence of his being unable at that time to command the necessary statistics from which to draw the certain and practical conclusions which he is at present enabled to do from the additional information now available, first, as regarding the number and capacity of covered markets necessary in relation to the population and area of the inhabited centre. He choses Rome as a practical example by means of which to illustrate his ideas, presenting the figures and facts upon which he bases his conclusions in regard to the best means of satisfying its needs in regard to covered markets, wholesale, partly wholesale, and retail; secondly, as to the construction of covered markets considered as a building speculation, Signor Boldi states that from the additional statistics now available it is a necessary conclusion that covered markets are to be considered as one of the best enterprises that offer themselves to a public administration, and gives a financial statement to demonstrate that it would be remunerative to the municipality of Rome to provide the eity with properly constructed and regulated covered markets. The figures are also given of the cost of construction and administration of covered markets in many European cities, and the return yielded by them, the interest varying, but being generally high. There are plates of plans for two covered markets.

Practical Notes on Rope Driving. By M. E. NewYork: Street Railway Publishing Company. 48 pp., $5\frac{1}{2} \times 9$ in.; 50 cents.

The pamphlet before us consists of a reprint of articles which originally appeared in the *Street Railway Journal*, and which may be highly commended. In the first chapter the advantages of ropes over belting for dynamo driving are stated generally and very clearly. The second chapter is historical, and in about four pages describes how this system of driving machinery originated, and gives as much information of that branch of the subject as the general reader will care to have. The third chapter is on The Make and Strength of Ropes, and compares ropes made in different ways and of different materials, and gives tables of ultimate and working strength of ropes. The fourth chapter is on Friction, Tension, Pulley Grooves, etc. On this the author says: "Without entering into an elaborate mathematical investigation of this part of the subject, it may here be sufficient to state that the resistance of a rope to slipping in the pulley groove depends: (1) Upon the coefficient of friction existing between the surface of the pulley groove and the rope; (2) on the angle of the groove; (3) upon the arc of contact or portion of the pulley circumference embraced by the rope; (4) upon the initial tension; and (5) indirectly upon the velocity of the rope." Each of these topics is briefly yet clearly discussed. Other chapters follow, on Horse Power of Ropes; Weight and Speed of Ropes—Centrifugal Tension; Length of Drive and Pulley Grooves; Relative Merits of the two Systems of Rope Driving; Splicing and Care of Ropes and Cost of Rope-Driving Plant. All of these topics are briefly discussed in an admirably clear style, and the reader goes on with the conviction that the writer has something to say which is worth knowing, and tells it in a very agreeable and intelligible way. Altogether this modest brochure may be highly commended to our readers who have any interest in the subject which it discusses.

Elements of Mechanical Drawing; Use of Instruments, Geometrical Problems and Projection. By Gardner C. Anthony, A.M., Professor of Drawing in Tufts College. Boston: D. C. Heath & Co. 98 pp., $5\frac{5}{8} \times 7\frac{1}{2}$ in.; 32 folded plates; $1.50.

The title of this book might, perhaps, have been more properly "Geometrical Drawing," as it only goes as far, or little beyond, instruction iu drawing geometrical figures, a later volume on machine drawing being announced. The first chapter is on the Outfit and Use of Instruments. Regarding the first, some directions might with advantage to the student have been given to him for the selection of his instruments. The author advises that this should be entrusted to one experienced in their use. Of course where students have the advantage of a teacher and attend a technical school this is all very well; but it often happens that advice which is competent is not available. The second chapter is on Geometrical Definitions, Useful Propositions, and Geometrical Problems; the third on Conic Sections; the fourth on Projection; the fifth on The Development of Surfaces; the sixth on The Intersection of Surfaces; the seventh on Screw Threads, Bolt Heads, and Bolts; and the eighth on Isometric and Oblique Projection.

The directions for working out all the problems for the use of instruments, etc., are all very clear, and although the book is apparently intended for a class-book, a student ought not to have much trouble in understanding it without a teacher. The plates are printed on sheets large enough so that when

they are unfolded the illustrations are free and clear from the text, so that its pages can be referred to and turned over without disturbing the plates. These are all well drawn and clearly engraved and printed. The only animadversion that seems to be called for is the binding. The sheets are fastened together apparently with wire, so that it is impossible to open the pages and have them remain so without holding them. Another defect is the absence of an index. If the author would add one, and the reader would supply himself with a small "jimmy" to pry the pages open, he will find the book is an excellent one.

Lettering of Working Drawings. By J. C. L. Fish, C.E. New York: D. Van Nostrand Company. 38 pp., 8⅝ × 12¼ in.

The purpose of the author in this book has been to give draughtsmen directions for lettering drawings, and with this object in view, he has given a series of different styles of lettering made up directly from working drawings. Preliminary to a series of designs of letters he gives directions for the formation of a standard alphabet, and observations "in practice work," titles, etc. After many years of experience we believe that most draughtsmen come to the conclusion that rules for forming and designing letters are to a great extent useless. Imitation is about the only rule a boy who has any aptitude for lettering will need. Give him any kind of an alphabet and let him copy the letters, and if he can't learn to do it in that way, rules for their proportions won't help him much.

The book before us will be useful in giving designs of various kinds of letters which are easily made with a pen, and by adopting such forms a draughtsman may save a great deal of time which would be wasted if he tried to imitate on a small scale the work of a sign painter or engraver.

The most important thing about the lettering of a drawing is, first, that it should adequately designate the object represented; next, that it should be distinctly legible; third, that the scale of the drawing should be given and the date when completed, and the draughtsman's name. All of these are of importance—at times of very great importance. The style of the letters ordinarily makes very little or no difference; often the more style there is, the worse the taste displayed. About the only rule that the writer has found useful in lettering is, first, draw boundary lines for the top and bottom of the letters; then sketch in the letters by the eye with a pencil before inking. In doing this any desirable style of letter may be imitated, and good specimens of type or lettering which can be easily imitated with a pen are useful. The young draughtsman will then find that his main strength and awkwardness are the great difficulties in the way of doing good work, and that only by practice, care and the exercise of good taste can he acquire skill.

Another rule, or, rather, practice, which has been found useful in laying out titles symmetrically, the author of the book has not referred to. Before putting a title on a drawing it should be first written out in full on a separate piece of paper and arranged in the different lines it is intended to appear on the drawing, thus:

Design of

Quadruple-Track Draw-Bridge

over the

Harlem River.

Scale ⅛ in. = 1 ft. January 25th, 1894.

Benjamin Borosson, Draughtsman.

Having decided on the space in which this title is to appear, draw horizontal boundary lines to limit the size of the letters of each line. Then draw a vertical pencil line through the middle of the space in which the title is to appear. Now count the letters in each line of the title, including each space between words as a letter, and mark the middle letter or division between letters of each line. Then begin with the middle of each line at the vertical centre line and sketch in the last portion of each line of the title in the way it is read, and the first part backward, the written title being the guide to prevent mistakes. This will insure each line being symmetrically disposed, or nearly so, in the space devoted to the title. If, owing to the variation of the size of the letters, in the first and last parts of any of the lines it is not symmetrical, the pencil lines can easily be changed before it is inked in.

Our advice to young draughtsmen is to ignore rules for lettering; to simply imitate good examples, and depend upon their "natural sense" instead of science in putting titles on drawings, and to bear in mind that a gay and fancy title on a drawing is nearly always in bad taste, and that the style of the title is of very little importance, but legibility and definiteness are.

BOOKS RECEIVED.

Notes on Government Railroads. By Arthur Pew, Macon, Ga. 68 pp., 6 × 9⅝ in.; 35 cents.

TRADE CATALOGUES.

In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. The advantages of conforming to these sizes have been recognized, not only by railroad men, but outside of railroad circles, and many engineers make a practice of immediately consigning to the waste basket all catalogues that do not come within a very narrow margin of these standard sizes. They are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

STANDARDS:

For postal-card circulars	3⅝ in. × 6¼ in.
Pamphlets and trade catalogues	3½ in. × 6 in.
	6 in. × 9 in.
	9 in. × 12 in.
Specifications and letter paper	8½ in. × 10⅝ in.

Pitts Agricultural Works, of Buffalo, send us a calendar for 1895 with a very good wood engraving of one of their double-cylinder steam road rollers printed on the card on which the calender is mounted.

Pittsburgh Crushed Steel Company, Limited, Manufacturers of Steel Emery and Steelite. 8 pp., 3½ × 5⅝ in.

The manufacturers tell us what their steel emery and steelite will do, but do not explain what it is. A little explanation regarding the latter point would add to the interest and usefulness of their advertising pamphlet.

Henry C. Ayer & Gleason Company, of Philadelphia, have sent us some of their sheets describing the portable crank-pin turning machine, the Johnson self-feeding boiler-tube expander, and portable stay-bolt cutter, all of which this new company manufactures. Their works and office are in Philadelphia, the latter in the Betz Building.

Test of the Steamer "Madagascar," Conducted by Henry Penton, of the Frontier Iron Works, of Detroit, Mich. 14 pp., 5¼ × 6½ in.

The machinery of this steamer was furnished by the company named, and the boilers by Messrs. Wickes Bros., of Saginaw, Mich., which were fitted with Howden's system of forced draught by the Dry Dock Engine Works, of Detroit. The object of the test was to show the superior economy of this system. Besides giving the result of this trial, it also gives engravings of the steamer, its engines, and indicator diagrams.

Consolidated Car-heating Company, Albany, N. Y. Part XII: Electric Heaters. 28 pp., 6⅝ × 10⅝ in.

This is another number of the series of excellent catalogues issued by this company. It sets forth in considerable detail the advantages claimed for the electric heaters manufactured by this company; gives engravings showing the interior of cars equipped with these heaters and details of the apparatus used; a table showing fuel and other cost of heating by this system; a full description of the apparatus and direction, for operating it; illustrations of house heaters and letters commendatory of the system. The pamphlet, like its predecessors, is well printed, the illustrations are good, and the descriptions clear.

The Tinker Patent Storm Window for Locomotive Cabs, Lighthouses, Pilot Houses, etc. H. W. Tinker, Patentee, Springfield, Mass. 4 pp., 8½ × 11 in.

In this circular the inventor illustrates a device for prevent-

ing snow, ice, frost, etc., from adhering to locomotive cab and other windows in cold weather. The invention consists in making the window glass double, and admitting warm water between the two panes. This is done by rubber tubes, suitable valves, etc. Some excellent testimonials speak very approvingly of the invention. Without any practical experience in the matter, it would seem as though warmed air would be better adapted for this purpose. The air-brake pump might furnish the very small supply required.

Compressed Air. What it is Used For. Clayton Air Compressor Works, 26 Cortlandt Street, New York. 1 p., $8\frac{1}{2} \times 13\frac{1}{2}$ in.

This sheet gives a list of about seventy uses in which compressed air is now employed in the operation of machinery, and for which they furnish some or all of the appliances. It is of especial interest to engineers, railroad men, machine and construction shops, granite and marble works, chemical works, sugar-refiners, rubber and silk mills, tin ware, pipe and hose manufacturers, and to all industries which use artesian wells, automatic sprinklers for fire protection, oil for fuel, and to physicians, for hospitals or baths in which sprays for curative purposes are used. The list is mailed free on application.

The Phœnix Iron Works Company, Cleveland, O. 36 pp., $6\frac{1}{2} \times 9\frac{1}{2}$ in.

This company makes cranes, foundry ladles, hydraulic presses, sheer legs, turn-tables and general machinery, all of which, excepting the last, are illustrated in their catalogue. The cover has a very neat lithograph representing a travelling crane, and the droll idea is represented of the earth suspended from it. The inside of the book has illustrations showing various kinds of travelling and jib cranes adapted to a variety of uses. There are also views of a portable or locomotive crane, the gearing for travellers, crab winches, a turn-table, foundry ladle and hydraulic press. Various tables, testimonials, etc., complete the volume. The illustrations are generally good, although some of these representing the interiors of foundries are indistinct, owing to the difficulty of making photographs with insufficient light. That the use of cranes has been immensely increased is shown by the number of firms which are now engaged in manufacturing them.

The Sargent Company Railway Brake Shoes, Chicago. 11 pp., 6×7 in.

This catalogue gives an excellent description and illustrations of the brake shoe which the company manufactures, and a statement of its advantages. The general principle of the construction of this shoe is to so dispose of the material that in applying the brakes their wear on the wheels will come on those parts—the inside and top of flange and outer portion of tread—which are not worn by the rails. By this means the brake shoes help to wear the wheels into their proper form instead of assisting in their deterioration. The effects of the old brake shoes and the way in which the improved ones act is clearly illustrated by sectional views and a very lucid description. A good perspective illustration made from a washed drawing helps to make the description clearer.

In the last paragraph it is said that the Sargent Company have prepared models of their shoe for distribution among railroad officials who are interested in it. If this includes editors of railroad papers we will express thanks in advance for one of them.

The Finlayson Upright Water-tube Boiler for Marine and Land Use. Manufactured by the Finlayson Boiler Company, Limited, Detroit, Mich. 21 pp., $6 \times 7\frac{1}{2}$ in.

The amount of attention which is now given to water-tube boilers is indicated by the number of manufacturers' descriptive catalogues which are published. The one before us describes a boiler which is not yet very generally known, but is a promising candidate for public favor. Its special feature, it is said in the publication before us, is "the placing of all steam-generating pipes in a perpendicular position. The only other boiler, in our knowledge, in which this requirement has been recognized is the so-called drop-tube boiler with sealed ends, suspended from a crown-sheet over the fire. As, however, in this type the downward movement of the water and the upward movement of the steam is accomplished in one and the same tube, the special advantage of the Finlayson boiler, in bringing the water supply into the pipes from the bottom, is fully apparent."

The pamphlet is well printed, and is illustrated by good wood engravings showing perspective views of the boiler, and outline engravings representing sections. The latter are hardly up to the standard of a first-rate mechanical draughtsman's art.

INTERCHANGE AGREEMENT BETWEEN RAILROAD COMPANIES.

The following agreement has been entered into by all the railroads centring in Chicago, with, we believe, one exception :

"We, the undersigned, on behalf of our respective roads, agree to interchange cars with the understanding that, in addition to the defects enumerated in Rules 7, 8 and 9 of the M. C. B. Rules of Interchange for which owners are responsible, the following items shall also be treated in the same way —viz. :

"1. Couplers or Drawbars, Drawbar Springs, Drawbar Pockets or Spindles, or their substitutes.

"2. Draw Lugs and Attachments, Draw Timbers, or their substitutes.

"3. Dead Woods or Buffers.

"4. End Sills.

"5. Longitudinal Sills.

"6. Cracked End and Corner Posts.

"7. Any Parts of Truck, including Brake Beams, and attachments, failing under fair usage.

"8. Centre Plates and all Body Castings.

"9. All Bolts.

"10. Roofs and Running Boards defective.

"11. Loose and Decayed Sheathing or Fascia Boards.

"It is further understood and agreed :

"*First.* That if the damage exceeds the items enumerated under No. 1, so as to include any or all of the items under head of No. 2 or 3, that in such case the damage shall be considered due to unfair usage, and no bill shall be rendered ; the same agreement to govern in items 2 and 3. Also, that in the case of longitudinal sills no bills shall be rendered for replacement of more than two sills.

"*Second.* That cars which are the property of the railroad companies, parties to this agreement, shall be interchanged between the parties hereto without requiring cards for defects which may exist in the parts enumerated above.

"*Third.* That in receiving cars from railroad companies, not parties to this agreement, or in interchanging cars not belonging to parties to this agreement, the rules of the M. C. B. A. for the interchange of traffic shall prevail.

"*Fourth.* That nothing in this agreement shall be so construed as to require any of the parties hereto to accept cars which may in their opinion be unsafe to run, or unsuitable for carrying freight, or with defects for repairs of which they are not authorized to bill, unless the party offering the car furnishes a proper M. C. B. defect card.

"*Fifth.* That in case any party to this agreement should be required to furnish M. C. B. defect cards for any of the items covered by this agreement on cars owned by any party to this agreement, and a bill be rendered on such card, the bill and card shall be a voucher against the party owning the car for an amount equal to the amount of such bill.

"*Sixth.* That if any party to this agreement should find it necessary to make repairs to any of the items covered by this agreement, the damage to said items not having been caused by collision or derailment, then and in such case the party doing such repairs shall have authority to bill against the party owning the car for the cost of such repairs, the charges for labor and material applied and credits for scrap or good material removed, being in accordance with the M. C. B. Rules of Interchange, and the party so billing shall certify on the face of the bill that the damage billed for was not caused either wholly or in part by collision or derailment, and that there were no further repairs made or required in connection therewith, the certificate reading as follows : 'I hereby certify that this bill is in accordance with special agreement for interchange of cars.'

"*Seventh.* That in case any party shall make repairs under this agreement, such repairs shall be made strictly in accordance with M. C. B. rules. Evidence that the repairs have not been so made will be authority for non-payment of bill, or for rendering counter bill in case original bill for repairs has been paid.

"*Eighth.* When repairs are made under this agreement the party making such repairs shall immediately notify the owner of the car, giving date, place, and nature of repairs.

"*Ninth.* In case any party to this agreement may desire any other party to hold material removed from cars, under this agreement, for inspection, the same shall be held, after notice has been received, for a period not exceeding 30 days subsequent to the date of repairs to such car.

"*Tenth.* Transfer roads may become a party to this agreement by assuming responsibility for any new defects which may be caused while cars are in their possession ; but shall not be authorized to bill for repairs made under this agreement.

"*Eleventh.* That there be an executive committee of five appointed, to whom disputes shall, under this agreement, be referred, their decision to be final and binding; also to make rules for the transaction of the business of this Association.

"*Twelfth.* Bills for repairs should not be made for damage when there is any evidence of carelessness in handling the equipment.

"*Thirteenth.* Any railroad may become party to this agreement by notifying Chairman of Executive Committee and signing agreement.

"*Fourteenth.* That this agreement may continue indefinitely, and that any party hereto may withdraw from the agreement by giving notice to that effect in writing to Chairman of Executive Committee, said notice to be given at least thirty (30) days prior to the date on which such withdrawal goes into effect."

NOTES AND NEWS.

Rubber-Headed Nails.—Rubber-stud blocks are being experimented with on the steps of the cars used by the Glasgow & Southwestern Railroad, with a view of testing their suitability as a preventive to slipping on entering or leaving the car. These blocks consist of inch-square iron plates with rubber on one side and nail points on the other. They are readily driven into the wood.

New Ship-building Plans.—It is reported that Lewis Nixon, the Superintending Constructor of Cramp's ship-yard, and who was formerly Naval Constructor in the U. S. Navy, has leased for five years the ship-building department of the works of Samuel L. Moore & Sons' Company, at Elizabethport, N. J., and that he will use this ship-building yard for the construction of a lighter class of vessels than are now built at Cramp's yard, both for the Navy and for sailing purposes, notably racing yachts.

New Use for the Locomotive.—A novel application of the locomotive is to be made in Detroit in laying the pipes of the international gas main across the Detroit River. The plan is as follows: At the foot of Orleans Street a ditch has been dug 20 ft. deep, beginning at the water's edge and sloping back to the surface of Franklin Street. At the bottom of the ditch is a plank trough, and in it is 600 ft. of the pipe. At the river end is a conical head in which is a large iron ring. A cable will be attached to this and taken across the river, where it will be made fast to three Grand Trunk Railway locomotives, which will pull it across as fast as new lengths are attached on the American shore. The clamps on the joints will weigh about 1,000 lbs. each, and are for the purpose of holding the pipe at the bottom of the river.

Electrical Railroads in Ohio.—Martin Dodge, of Cleveland, the President of the Ohio Road Commission of 1893, proposes to build a great network of electric lines all over Ohio at the public expense. He would have the public construct lines in the same manner as canals and highways have been built in the past and are being built now, the counties paying half the expense of the immense work and the State the remainder. He estimates that this would require 4,000 miles of road, and would cost over $20,000,000. The estimate of $5,000 per mile, which he fixed, is below the average, it is said, of the expenditure on the country lines now in operation in the State, and the work done by the public would still further increase this expenditure. Some of the critics of Mr. Dodge's scheme say that it would cost twice $20,000,000, but the projector sticks to his estimate. He says, however, that even if it did cost more than he has figured, it would still be a first class investment for the public. There is a probability that the scheme will be brought before the next Ohio Legislature.

Mending a Shaft at Sea.—It seems that it makes a difference whether the broken shaft of a steamship at sea is on a fast liner or a freighter, as to the amount of credit given to the engineer who successfully splices the break; for when the *Umbria's* shaft was broken a year and a half ago all the papers were loud in their praises of the engineer who successfully mended it, and yet hardly mention has been made of one done recently. The steamer *Halkar* broke her shaft when four days out from Swansea; a heavy sea was running at the time, and the break was through an intermediate shaft on a diagonal line. After a long struggle the engineer, Matthew B. Taylor, succeeded in drawing the two ends together, and then with hand drills drilled two holes through the 11-in. shaft; heavy bolts were run through these holes and secured in place; in addition to this, large iron clamps were bolted around the seam and white metal composed of zinc and lead was poured into the cavities of the fracture. The vessel then put about, and nine days after the breakdown was in Queenstown.

The Gordon Disappearing Gun Carriage for a 10-in. rifle was tested for time and rapidity on December 3, at the Sandy Hook Proving Ground, in the presence of the Assistant Secretary of War, the Ordnance Board officials, and representatives of the builders, the Morgan Engineering Company, of Alliance, O. Thirty-two shots were fired within an hour, and the trial was regarded as an entire success. This carriage is slightly different in its equipment from the one tested some time ago. It is worked by electric motors, one for the air compressor and one for moving the carriage. The total weight of the carriage is 325 tons, while the gun weighs 27 tons. The contract price was $48,000, and, according to the terms, 10 shots were to be fired in an hour, with a bonus of $2,000 for each additional shot fired. Monday's performance, therefore, secures to the builders a bonus of $44,000.

Signaling by Sunlight.—A newspaper dispatch says that a message was recently signaled with sunlight from the top of the Equitable Building, in Denver, to the summit of Pike's Peak, 66 miles. Several days before Sergeants McGlone, McLaughlin and Bissell left Denver for Pike's Peak to make the experiment. This was the message which was flashed from the top of the Peak:

PIKE'S PEAK, September 3.

To Captain Glassford, Denver:

We greet you *via* sunbeam. Arrived at 4 P.M. yesterday. Snow-storm prevented our opening station. McGLONE.

Experiments will be continued at certain hours, at the end of which the signal men will start for their attempt to flash a message from Mount Uncompahgre to Mount Ellen, 183 miles. The flashes of the mirrors on Pike's Peak could be distinctly seen by the naked eye during the transmission of the message. The Peak was first called from the Denver side of the line, and within five minutes after the operators began their work came the response.

Interior Rust of Boilers.—Iron is said to be incapable of decomposing water at ordinary temperatures except in the presence of air or by galvanic action when some electro-negative substance is connected with it. For this reason we should expect little corrosion from rust in the interior of a boiler, as air is only periodically admitted when the boiler is cooled down.

There is, however, the dissolved air of the feed, and this is reduced in amount when the feed-water is previously heated. Under any circumstance the rust found in the interior of a boiler is of a different character to ordinary iron rust. It is, in the first place, of a much darker color. That formed in the upper spaces by steam alone is almost black, partaking of the nature of that black magnetic oxide which is formed in the Baff process by steam superheated to 950° F. The latter oxide is of course completely protective when once formed, and the oxides formed in the interior of a boiler, although not of a protective nature, are nevertheless far less corrosive in their action than those formed under ordinary circumstances. This is another reason for supplying a pure feed-water to steam boilers. The corrosion of the interior when not assisted by adhesive deposits and organic acids from the lubricants is comparatively slow, and the life of a boiler may be greatly prolonged by the exercise of care in this particular.—*Indian Engineering.*

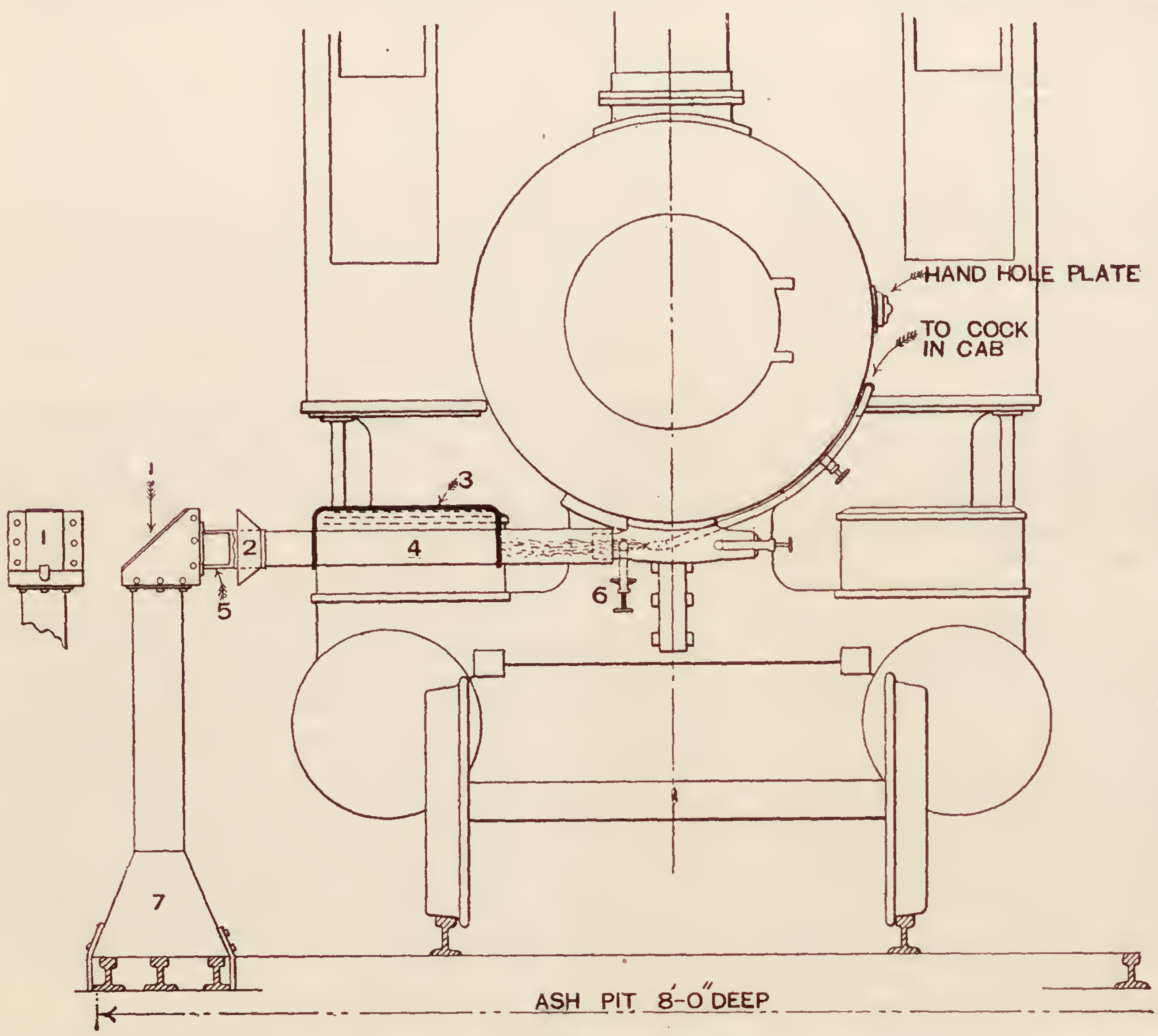
How to Approach a Mechanical Problem.—At the inaugural meeting of the fourteenth session of the Institution of Junior Engineers, held on November 16, Mr. Alexander Siemens gave some wholesome advice to young engineers and inventors. In the course of his address, he dispelled the fable about the circumstances which led to the invention of the steam engine. According to the popular version, Watt, as a small boy, saw the lid of a tea kettle move up and down, when the water was boiling, and this suggested to him the construction of the steam engine. As a matter of fact, Watt made himself acquainted with what had been done before (a point altogether ignored in the popular version), and had to work very hard before he brought his invention to a successful issue. His example is typical of the true method of progress, and it may be said generally, that in order to approach a problem with the best prospect of success, it is necessary (1) to define, as accurately as possible, the want that exists, or the particular object that is to be attained; (2) to be well acquainted with the scientific principles which come into play: (3) to know how the want is met, or the object attained in practical life; (4) to find out what proposals have been made by others in the same or in a similar case. A careful attention to these requirements will prevent much disappointment and waste of energy. The records of the Patent Office show that one or more of these conditions is frequently ignored. A large class

of inventors do not realize that a knowledge of scientific principles would be an assistance in their efforts: or if they study science at all, they think they can acquire the necessary knowledge by a short study, and without much trouble.

The Conversion of Coal into Electrical Energy.—The problem of directly converting the stored-up energy of coal into available electrical energy is one of great importance; and as a first attempt to perform this operation, the experiments made by Dr. W. Borchers, of Duisburg, and which he described before the first annual meeting of the Deutsche Elektrochemische Gesellschaft, possess great interest. The author, in the first place, produced an electric current by the "combustion" of carbonic oxide gas. The original form of the apparatus used consisted of a glass vessel divided into three compartments by two glass plates which nearly reached to the bottom of the vessel. In the two exterior compartments copper tubes were placed, which served for the introduction of the carbonic oxide, while the middle compartment contained a bell-shaped mass of carbon. This carbon bell constituted one plate of the cell, and the oxygen was introduced by means of a tube within this bell. As electrolyte the author uses an ammoniacal or acid solution of cuprous chloride; this liquid readily absorbs both oxygen and carbonic oxide, and is therefore particularly well suited to form the electrolyte in a gas battery in which these gases are used. Coal gas which contains 5 per cent. of carbonic oxide was, after the first experiments, used in place of pure carbonic oxide. The copper tubes were weighed before and after each experiment, and no decrease in their weight was ever found. With such a cell working through an external resistance of 0.1 ohm a current of 0.5 ampere was obtained, while with an external resistance of 50 ohms the difference of potential between the terminals was 0.4 volt.

With a cell in which the outer compartments were filled with copper turnings, in order to increase the absorption of carbonic oxide by exposing a greater surface, and by using coal gas in place of pure carbonic oxide, a maximum current of 0.64 ampere was obtained, and by increasing the external resistance a maximum difference of potential of 0.56 volt was maintained. The E.M.F. obtained by calculation from the heat developed in the combination of CO and O is 1.47 volts, so that in the above experiment 27 per cent. of the energy of combination of the fuel is converted into electrical energy. Since a solution of cuprous chloride dissolves hydrocarbons, powdered coal was tried in place of carbonic oxide, when a maximum current of 0.4 ampere and a maximum E.M.F. of 0.3 volt were obtained. The above E.M.F. (0.3) corresponds to about 15 per cent. of the energy corresponding to the oxidation of carbon. In the case of the coal-dust, even when the liquid was kept in motion, there was always a considerable falling off in the current, while the pollution of the electrolyte by the coal would quite prevent its use. With the gases, however, there is no falling off of the E.M.F., and this pollution of the electrolyte does not occur.—*Nature.*

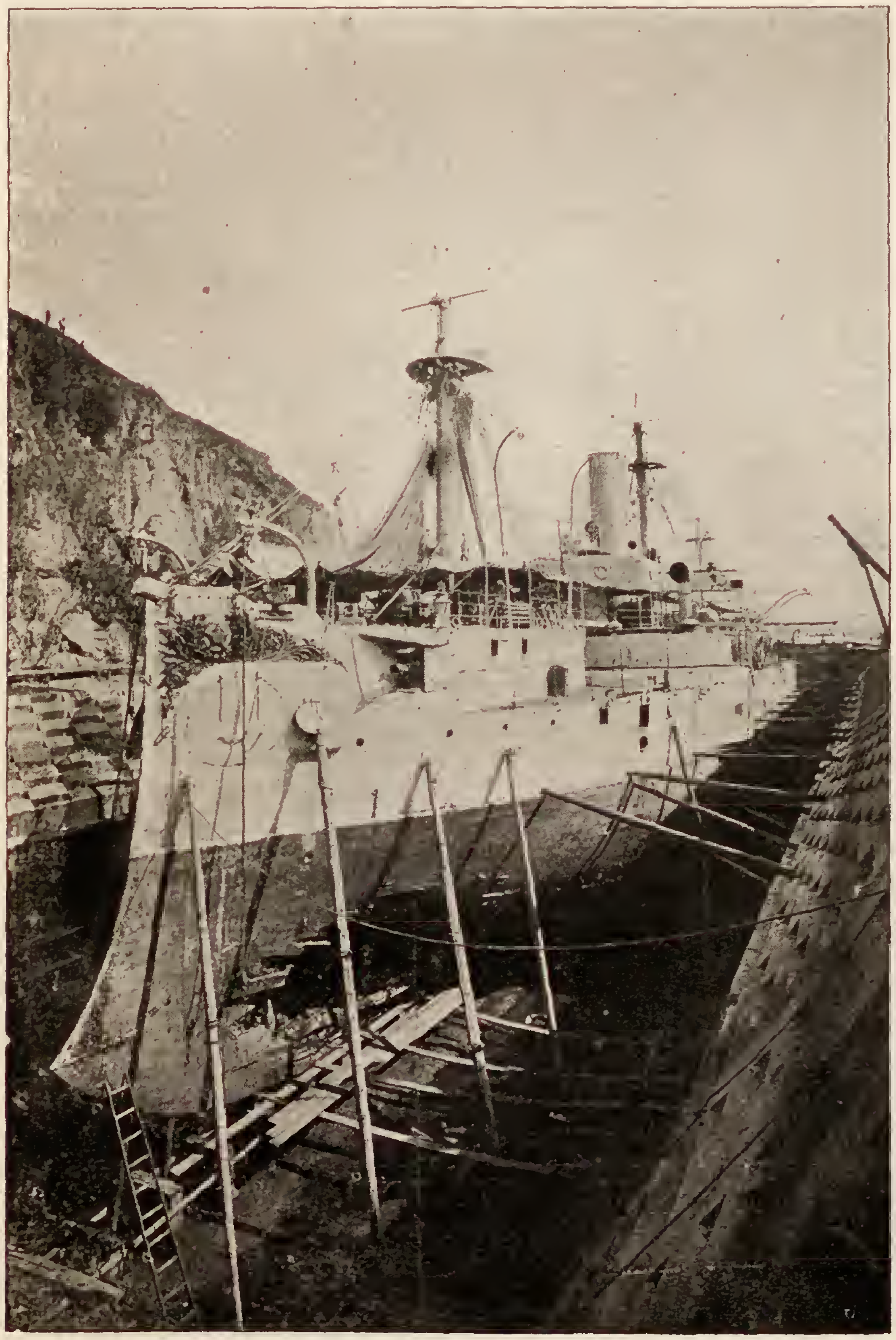
A Cinder Blow-off.—The mechanical officers of the Delaware & Hudson Canal Company have devised innumerable little wrinkles for easing the work in their department, many of which have already been illustrated in the AMERICAN ENGINEER. Here is another for getting rid of the cinders that accumulate in the front ends of locomotive and not blow them all over and into the bearings and working parts of the truck and machinery. It is in use at the ash-pits at Oneonta, N. Y. Bolted to the bottom of the front end is a casting containing the steam-pipe and nozzle indicated by the dotted lines in the engraving. Each side of the casting is closed by a valve (6), so that the cinders may be blown out in either direction, although it should be added that some engines are only equipped with single-sided castings. To meet the difficulty that would arise from the turning of the engines, there is an apparatus on each side of the track. Leading off from the casting is a short length of pipe (4), which may be adjusted to position, when hot, by the handle (3). At the outer end the pipe slips over a projection on the standard at 5, where ashes and escaping steam are prevented from blowing back on the engine by the flare 2. The elbow is of sheet metal provided on the side against which the cinders impinge by a slide (1), which can be replaced when worn out. The standard (7) slides along the rails upon which it rests to a point opposite the engine. The action is very simple; after the adjustment of the parts the steam valve is opened, all of the cinders are blown out through the apparatus without raising any dust or flying over the machinery.



A CINDER BLOW-OFF, DELAWARE & HUDSON CANAL CO.

French Suburban Tramway. — If two American towns 20 miles apart were to be connected by a railway other than a full-sized regularly equipped steam road, it is safe to say that electricity would be the only motive power seriously considered for a highway line, and, further, that the road would be built standard gauge. The French do these things somewhat differently, however, for about a year ago a steam tramway was constructed on the 2-ft. gauge between Pithiviers, a station on the Orleans & Malesherbes Railway and Toury, a station on the Paris-Orleans Railway. This line is about 19 miles long, and the principal object was to foster the development of the beet-root sugar industry in the district which it traversed. The line was built by the Council of the Department, and is worked on lease by the Decauville Company, the builders of narrow-gauge lines, in an agreement which makes the authorities sharers in losses or gains exceeding certain maximum and minimum amounts. The Department hoped by the construction of this road to save considerable work on new highways. The line is laid at one side of the public road and not separated from it in any way. The necessary length from end to end has been increased to take in as much local traffic as possible. There are seven intermediate stations and six other stops to pick up passengers without luggage. Owing to

the opposition of the communes the line was made to pass round instead of through the villages. No shelter was provided for passengers at the stations, but only an open shed and a small office for parcels and for a weighing machine. Passenger tickets are issued on the train by the conductor. The gradients are generally about 1 in 100. The rails are 16 ft. 5



THE AQUIDABAN.

in. long, weighing 19.1 lbs. per yard. They are cold riveted to steel sleepers with six rivets to each rail. With a hollow steel sleeper it is found that a less depth of ballast is necessary than with a wooden sleeper, which is a considerable advantage on light lines. There are four engines, two being for freight trains weighing 9 (long) tons empty and 12 tons full. These are compound on Mallet's system. The two passenger engines weigh 7.2 tons empty and 8.5 tons full. There are two types of cars—viz., 10-ton open bogie cars weighing 3.17 tons, and 5 ton beet-root cars on four wheels. There is also a cattle car 32 ft. long, on bogies. The cost of constructing the line was $6,115 per mile, and the equipment cost $1,640 per mile. The line carried, in 1893, 27,235 passengers, and earned $10,430. The receipts are considered to have suffered greatly from the fact that the beet-root crop was a bad one. Important branches have been laid down by cultivators and manufacturers, and one great advantage of this type of line is the facility with which branches can be laid and moved as the gathering of crops may require.—*Philadelphia Record.*

Torpedo Effect.—The accompanying photograph is of the *Aquidaban* in dock after having been struck by a Whitehead torpedo. The water-tight bulkhead situated at the twelfth frame from the bow and the protective deck are intact. The ship made the passage from Desterro to Rio under her own steam and without repairs after being struck.

The *Gustavo Sampio*, which did the torpedoing, is a torpedo gunboat having a bow tube and two broadside launching tubes, two 20-pdr. rapid-firing guns, and four 3-in. rifles. She, in company with a torpedo-boat, something after the style of the *Cushing*, entered Desterro harbor, where the *Aquidaban* was at anchor, shortly after midnight, April 16.

The torpedo-boat advanced, and at 100 metres fired her bow torpedo. At 75 metres she launched her broadside; both missed. The *Sampio* then advanced, and at 75 metres fired her bow torpedo, which missed, and at 50 metres her port broadside. The last torpedo struck the *Aquidaban* about 10 ft. below the water-line, and 25 ft. abaft the bow, making a hole 12 ft. square on the port side, and a round hole 3 ft. in diameter on the starboard side. The plates for several feet around the port hole are crushed in. Very little pretence was made toward directing the tubes. Strings were led from the triggers of the broadside tubes to below decks, and they were fired in this way with no one on deck. The *Aquidaban* had machine guns at work on them before the first torpedo was launched, and search lights on soon after.

The torpedo was set for a depth of 5 ft. It had been charged for several days.—*Proceedings of the United States Naval Institute.*

Small German Ironclads.—The London *Times* said recently that since the year 1889 the German Government has launched a number of small ironclads of a class which is unrepresented in the British Navy, and which appears to deserve more attention than it has hitherto received. The first of the series, the *Siegfried*, was launched from the Germania Yard at Kiel in 1889; the next, the *Beowulf* (late commanded by Prince Henry of Prussia), and the *Frithjof*, were launched from the Weser Yard, at Bremen, in 1890 and 1891 respectively; the fourth, the *Heimdall*, was launched from the Imperial Yard at Wilhelmshaven in 1892; the fifth and sixth, named *Hildebrand* and *Hagen*, were launched from the Imperial Yard, at Kiel, in 1892 and 1893 respectively; and the seventh and eighth, provisionally known as "T" and "V,"* are now ready for launching, the former at Kiel and the latter at the Imperial Yard at Dantzic, a yard which, by the way, has never before built an ironclad, and has hitherto undertaken only wooden or composite vessels. The ironclads of this class were originally designed as coast-defence ships, and were more expressly destined for the protection of the two ends of the North Sea and Baltic Canal; but they have proved more suited for service as small battleships than for coast-defence work, and their sea-keeping and fighting qualities are considered so good that they are now classed as fourth-class battleships. During the recent manœuvres some of them formed the fourth division of the evolutionary fleet, and the captains' reports spoke most highly of all of them. The eight ships resemble one another very closely, though the later ones embody certain improvements which the earlier ones lack. For instance, those of more recent construction have nickel-steel armor, and "T" has water-tube instead of locomotive or cylindrical boilers. All are remarkable for the very small amount of wood that has been employed in their construction; and this fact, in the light of the great number of fires caused by bursting shells in both Japanese and Chinese ships during the recent action off the Korean coast, shows the prescience of the German Admiralty. Indeed, in the latest ships of the series there is hardly any wood at all. They are also steam-heated throughout. These little ironclads are 239 ft. 6 in. long, 49 ft. 3 in. broad, and, at

* See page 11.

a displacement of 3,500 tons, draw 17 ft. 9 in. of water. The engines, driving twin-screws, are of 4,800 I.H.P., and give a speed of between 15 and 16 knots. The armor consists of a complete all-round belt 7 ft. 6 in. broad and 9.4 in. thick, of two covered barbettes of 8-in. steel, of a 1.37-in. steel deck, covering engines, boilers, torpedo-rooms, and magazines, and of steel shields for all guns. The armament consists in each case of two 9.4-in. long Krupp breech-loading guns in the forward barbette, of one similar gun in the aft barbette, and of six 3.4-in. Krupp quick-firing guns, disposed three on each broadside. There are, besides, four torpedo ejectors, one being forward, one aft, and one on each beam. Two tubes are submerged. The torpedo armament of each ship has cost $140,000, and the gun armament $380,000; and the mean total cost per vessel is $1,614,000. Steam-heating and electric-lighting arrangements are fitted in all, and each craft has two very powerful search-lights. The *Siegfried*, *Beowulf*, *Frithjof*, *Heimdall* and *Hildebrand* are already attached to the North Sea fleet, and the *Hagen* forms part of the Baltic fleet, to which "T" and "V" will be added as soon as they are completed. It is probable that at least one more ship of the class, to be provisionally known as "W," will presently be laid down, although no definite provision for it has yet been made. Of ironclads of a larger class—namely, of 10,040 tons displacement—Germany has launched since 1890 the *Brandenburg*, *Kurfürst*, *Friedrich Wilhelm* and *Weissemburg*, at Wilhelmshaven, and the *Wörth*, at Kiel. It need only be said that a fifth vessel of the type is about to be laid down at Kiel.

Train Lighting by Electricity on the Danish Railways.—This paper summarizes the experiments on train lighting by electricity made on the Danish State Railways during the past two years. The method employed is that of storage in the train by means of accumulators, which are recharged at fixed points or termini of the line.

The railway system in question appears peculiarly suited to the plan adopted; the trains run backward and forward in such a manner as not to require a maximum of more than 4 hours' lighting even in the winter months, while ample time is secured at the terminal stations—up to 8 or 10 hours—for recharging. Moreover, they are not broken up at junctions, as is very often the case with main-line traffic; the same battery may, therefore, be used for lighting the entire train. Diagrams and detailed particulars are given to show the type of carriage flexible connecting pieces adopted, and also the system of wiring. Two separate circuits are fitted, so that on the conceivable failure of one the other may serve to keep lighted half the lamps (which are fixed in pairs). In each first-class compartment are placed two 8-candle-power glow lamps; second-class carriages and lavatories are fitted with two 5-candle-power lamps; while in the five compartments which make up a third-class carriage there are three 5-candle power lamps. These lamps are all stated to require 3.5 watts per candle power; their life at first did not exceed 200 to 300 hours, owing to the great vibration to which they are naturally subject, but by adopting special precautions in the way of spring attachments the length of life has been increased threefold.

The train battery consists of 33 cells, with three extra as reserve; the working potential is, therefore, 65 to 66 volts. The maximum rate of discharge is 18 amperes; the total capacity reaches 80 ampere hours. Each cell has 15 plates—seven positive, eight negative—and weighs in working order about 50 lbs. Current for recharging the batteries after use is taken from the dynamos employed for general electric lighting purposes at the terminal stations. At present the rolling stock equipped for electric light comprises seven luggage vans, seven passenger coaches with battery compartments, and 74 coaches fitted with circuits and lamps. The oil lamps previously used are kept as a reserve, but do not appear to have been required except when the carriages are run in trains not equipped for electric lighting.

The cost of thus equipping a train is stated thus:

Coach with two first-class, two second-class compartments, and two lavatories	$104.50
Coach with two second-class and three third-class compartments, also one lavatory	97.20
Coach with five third-class compartments	70.20
Luggage van	72.90
Battery, switchboard, etc	1023.30

or a total of $3,180.10 for a train made up of four first and second-class coaches, three second and third-class, five third-class, and one luggage van, with two batteries and fittings. There is in such a train a total capacity in illumination of 618 candle power, which at the normal rate requires 2,163 watts per hour, or 33.28 amperes at the battery voltage. As the hours of lighting do not exceed 1,000 per annum, the yearly expenditure of energy per train will average 2,162 units or kilowatt hours. Taking the cost of electric energy at the recharging station as being about 36 cents per unit, the total cost of energy in the lamps (with a 50-per cent. accumulator efficiency) is stated to be 1.4 cents per lamp hour. This result is compared with the cost of oil-gas lighting, which is given, under the circumstances, as being .2 cents per lamp hour; the unit of light is, however, slightly more in the case of oil gas.

The author then enters upon the question of total cost, with allowances for depreciation, sinking fund, attendance, etc., and concludes with suggestions as to switching out the lights in unoccupied compartments, also as to the use of more economical glow lamps. His opinion is generally that the experiments just made are still indecisive; a longer time and more experience, with improvements in detail, are required in order to say whether train lighting by electricity is the best method or not.—*Foreign Abstracts, Proc. Inst. C. E.*

The Machinery of Warships.—The *Times* gives the following abstract of an interesting paper recently read before the British Institution of Civil Engineers by Mr. A. J. Durston, Engineer-in-Chief of the Royal Navy, upon The Machinery of Warships. The first part of the paper was taken up with some descriptive remarks about the machinery of the fleet of 70 ships ordered under the Naval Defence Act of 1889, and of those vessels fitted with forced draft which preceded that fleet by a few years. Details were given of the engines, the length of stroke, the number of revolutions, the boilers and the furnaces of the various ships. Mr. Durston then made some interesting comparisons between the ships built under the Naval Defence Act and those built before it. He showed that the weight of the machinery and boilers of eight recent battleships is as a whole less per H. P. than in the six battleships of the *Admiral* class built prior to the act, the saving in weight arising from the use of triple-expansion engines and a higher steam pressure. The machinery of the battleships built under the act is, however, heavier as compared with that of the *Nile* and *Trafalgar*. Some of this difference is due to the heavier auxiliary machinery fitted in the former vessels, but it is mainly attributable to the heavier boilers provided to secure greater subdivision of the boiler power, increased facilities for access and repair and greater durability. The first-class cruisers built under the act, compared with previous ones, show a slight increase in power for tonnage at natural-draft powers, which is not maintained when the forced-draft powers are compared. In designing the first-class cruisers built under the act the object aimed at was the maintenance of a high continuous-steaming power, less regard being taken of the possible performances for short periods under forced draft. The same general features, though somewhat more marked, are obtained from a comparison of the second-class cruisers. Mr. Durston then proceeded to make some remarks on the question of leaky boiler-tubes, and enumerated a number of methods employed to mitigate the defect; these, he said, had made the leaky-tube question comparatively insignificant, so that one of the evils consequent on the use of forced draft had been successfully combated. Water-tube boilers for vessels other than torpedo-boats have been introduced in the *Speedy*, one of the torpedo gunboats built under the Naval Defence Act. In this vessel there is a material increase in the H. P. per ton for machinery and boilers. As regards the working of boilers for this type, immunity from leaky tube ends, the readiness with which steam can be raised, and the absence of all special precautions in their stoking are points in their favor. On the other hand, considerable attention is required in feeding them owing to the small quantity of water in them and the rapid evaporation; further, their steam space is not great, and care must be taken to avoid priming. In the *Sharpshooter* eight water-tube boilers of the Belleville type have been substituted for the old boilers of the locomotive type. The result of this change has not been any increase of H. P. per ton, but an improvement is shown as regards ability to maintain continuously a high power. In view of this fact, and also of the tactical and other advantages afforded by these boilers, it has been decided to fit them in the two first-class cruisers *Powerful* and *Terrible*, which are now being built. In another of the vessels constructed under the Naval Defence Act, the *Gossamer*, the Martin system of induced draft has been fitted to the two forward boilers, the two aft ones being left with their forced draft fittings. It is found that the draft can be accelerated equally by either system, but a larger fan is required for the induced draft. No superiority can be claimed for the latter as regards absence of leaky tube ends, and the for-

mation of scoriæ seems to take place equally with both systems. The induced draft, however, keeps the stokeholds cooler, and the stokers work in greater comfort. Consequently the stoking is better, and, as more control is obtained over the fires, there is a reduction in the amount of coal consumed. This system of draft is being fitted to one of the new first-class battleships now being built, and to another vessel of the gunboat class.

FOREIGN NAVAL NOTES.

The German coast-defence ironclad, provisionally known as "V," was launched on November 3 at the Imperial Dockyard, Dantzic, and, by direction of the Emperor, received from Count Haugwitz, the director of the yard, the name of *Odin.*

The German Government is about to make trials of a new "destroyer," or large torpedo boat, which has been built by Messrs. Schichan, of Elbing. She is 177 ft. 2 in. long, has a speed of 25 knots, and not only carries coal for 8 days' steaming, but has accommodation for men and officers vastly superior to that of previous boats of her size.

Another battleship was launched from the new dock of the Russian Admiralty on the Neva on November 9. This vessel is the *Petropavlofsk*, twin ship to the *Poltava*, which was launched recently. The *Petropavlofsk* is 375 ft. long, 70 ft. broad and ranks in the first class. Her displacement is 10,960 tons, and her engines, of 10,600 H.P., are calculated to give a speed of 17¼ knots. Her armor will probably be 16 in. thick amidships and half that thickness at the bow and stern. Her armament, which will presumably be similar to that of the *Poltava*, will be four 12-in. guns, eight 8-in., ten single-barrel and five 5-barrel Hotchkiss guns, and one Baranofsky gun. The *Poltava* has two turrets, each of which will contain two 12-in. guns.

The Austrian armored ram-cruiser *Kaiserin und Königin Maria Theresia*, which was launched last year at the Stabilimento Technico, Trieste, is now ready for her trials. She is practically a steel twin-screw cruiser, with a 3.9 in. belt, which is curved and continued inboard so as to form a protective deck 2.3 in. thick. She is 351 ft. long, 52 ft. 4 in. broad, and, at a mean draft of 20 ft., displaces about 5,100 tons. Her engines, of 9,800 H.P., are expected to give her an extreme speed of 19.8 knots, which it is possible may be slightly exceeded. Her armament consists of two 27-ton 9.4-in. Krupps in steel 4-in. barbette turrets, one forward and the other aft, ten 5.9-in. quick-firing Krupps, five on each broadside, in two tiers of sponsons, 13 smaller quick-firing guns, and four torpedo-ejectors. She will carry 660 tons of coal, or sufficient for 4,500 knots' steaming. She is the largest of three somewhat similar cruisers which have been launched lately in Austria. Of the others, the *Kaiser Franz Josef I.* was built at Trieste in 1889 and the *Kaiserin Elisabeth* at Pola in 1890.

A preliminary trial of the torpedo-boat destroyer *Ardent*, built and engined by Messrs. J. I. Thornycroft & Co., of Chiswick, was made in November at the mouth of the Thames. The *Ardent* is the first of three sister vessels which have been designed for the Royal Navy by this firm, and is 15 ft. longer than the *Daring* and *Decoy*, also built at Chiswick. The extra length has been given in order to meet the demands of the Admiralty for greater accommodation. The following are the principal dimensions of the new vessels: Length over all, 200 ft.; breadth, 19 ft.; depth, 14 ft. The engines are similar to those fitted in the *Daring* and *Decoy*, being of the three-stage compound type, with two low-pressure cylinders. The diameters of the cylinders are: High-pressure, 19 in.; intermediate, 27 in.; and the two low-pressure, each 27 in. The vessel is twin screw. The boilers are of the Thornycroft water-tube type and somewhat larger than those of the *Daring* and *Decoy*. A notable point in this vessel is the automatic boiler-feed control, recently introduced by Messrs. Thornycroft. Talc is used in place of glass for the boiler water gauges, the increased pressures now used necessitating a departure from the old gauge glass. The vessel left Greenhithe at 10.15 A.M., and ran down to the measured mile on the Maplin Sand. After a series of progressive runs below full power, a full-speed trial was made, the mean of two runs with and against tide being 29.182 knots. This is the highest speed yet attained as a mean of runs with and against tide, the *Daring*, it will be remembered, having made a single run at 29.268 knots. The quickest run with the *Ardent* was 30.151 knots, but this was with the tide, while the *Daring's* run was against a slack tide on the same course. The power developed was about 5,000 H.P., the boiler pressure being 210 lbs. to the square inch, and the mean revolutions 407 per minute.

LABOR NOTES.

Industrial Conciliation in the North of England.—A correspondent of the *Times*, in commenting on the success of the Board of Conciliation in settling a trade dispute in the North of England, says, what is worth consideration by both employers and men in this country:

"I believe that the secret of the remarkable success which has attended the manufactured iron trade board is largely due to two causes. In the first place, the operative representatives, as they are called, are directly elected by the men to that special office, and do not sit at the board in virtue of their holding other positions in the men's organization. In the second place, all the proceedings of the Board (except, of course, those of the standing committee) are, and have been almost since the establishment of the Board, open to the press, and are, as a rule, pretty fully reported. The men are thus able to see for themselves that their delegates use every available argument in support of their own case, but, what is equally important, they are made acquainted with the case put forward on behalf of the employers. In every case of the failure of an industrial conciliation board or committee which has come under my own observation, such failure has been largely attributable to a loss of confidence in the board on the part of the men connected with it, engendered and fomented by the fact that its sittings were held in secret."

Practical Conciliation.—"The moulders in the northeastern districts of England," a correspondent of the London *Times* says, "have brought their long controversy with their employers to a close, and have united with them to form the 'Board of Conciliation for the Iron-Founding Industry of the Northeast Coast.' The parties to this board are the Associated Employers of the Tyne, Wear, and Tees and Hartlepool districts, and the Friendly Society of Iron-founders of England, Ireland and Wales. The board, which consists of 11 employers and an equal number of moulders' representatives, has just elected Sir Andrew Noble, of the Elswick Works, as its chairman, and Mr. T. R. Johnson, of Sunderland, a moulder, as its vice-chairman, with two secretaries nominated by the two parties. The declared object of the board is to 'regulate general advances or reductions in the wages of the moulders.' But it is further stipulated: 'Any other general question may be brought before the board. If any question arises which one of the parties considers it desirable to submit to the board, although the question may not be of a general nature, the same may be submitted by the secretary of the one party to the secretary of the other party to be considered, and, if both parties agree, it may thereafter be brought before the board.' The 12th rule provides:

"'Failing settlement by the board of any question referred to it by the standing committee, the same may, by common consent, be submitted to three disinterested gentlemen mutually approved by the board, the decision of whom, or of the majority of whom, shall be binding and conclusive. But if the board fail to agree in the choice of three gentlemen willing to act, each party shall elect its own referee, and the two referees so elected shall nominate a third to sit with them, and their decision, or the decision of the majority of them, shall in like manner be binding and conclusive.'

"The employers in entering these conciliation boards, which are being formed in the North of England, believe that the new institutions will promote their interests by steadying the conditions of trade, by saving them from petty harassments as well as costly strikes, and by thus enabling them to cope more effectively with the foreign competition which they daily feel to be growing keener and more serious."

National Free Labor Congress.—The second annual free labor congress has recently been held in London. At that meeting a member proposed:

"That, in the opinion of this congress, the senseless and abortive strikes which have occurred in many branches of industry throughout the country have had a most disastrous effect upon the living standard of the wage-earning classes, and are mainly the cause of the present stagnation of trade and consequent want of employment." In order to show the prevailing system of coercive tyranny enforced by unions, he said that he had been systematically persecuted and boycotted by the union of his trade for 4½ years, and he had been prevented from doing 6 months' work at the Boyton show at

Earlscourt. In addition to that he had been threatened with violence. He looked upon the association as the savior of our working population.

Another member seconded the resolution, and mentioned a case where a workman on the Tyne had committed suicide owing to the tyrannical methods of the union. The resolution was carried unanimously.

Mr. S. Beale proposed: "That, in the opinion of this congress, no alteration in the Conspiracy and Protection of Property Act (1875) will be satisfactory which does not provide that, while recognizing legal the right of workmen to picket during strikes for the *bona fide* purposes of giving and receiving information, picketing in such numbers as must inevitably terrorize those who may be willing to work shall be prohibited." He defined picketing as violence, intimidation, and wholesale destruction of property, giving instances of recent picketing outrages to show that trade leaders were wrong when they said that the object of picketing was to give notice to strangers in search of employment.

Mr. Ritson seconded, and argued that picketing, far from becoming a rightful privilege or the exercise of moral suasion, had become an atrocious means of outrage, crime, and intimidation. The police at Hull were in possession of a very fine collection of "moral suasion instruments" which had cut out men's eyes and broken heads. Picketing was also hurtful to the employer and to the general course of trade, and, though a Liberal in politics, he said that all honor was due to Lord Salisbury for saying that he thought some alteration of the law was necessary. He himself had been knocked senseless by a trade-union ruffian, armed with a knuckle-duster, for working at strike time and for exercising individual freedom in rightful employment.

Mr. Smith seconded, and gave personal instances of the effects of picketing during the dock strike at Hull, asserting that free-labor workmen were forcibly taken to picket stations and brutally ill treated.

The resolution was unanimously carried.

There is room for a Free Labor Congress in this country.

Labor Legislation in New Zealand.—A bill has recently been introduced into the New Zealand House of Representatives which is entitled "An Act to Encourage the Formation of Industrial Unions and Associations, and to Facilitate the Settlement of Industrial Disputes by Conciliation and Arbitration." The industrial unions and associations which are to be registered under this act are aggregations of employers or employed, or aggregations of trade unions. Thus an industrial union is to consist of more than seven persons, either employers or employed, who unite in trade or industrial interests. Its rules have to follow certain broad lines laid down in the bill, and are to be filed with the Registrar of Friendly Societies, who is the person appointed to register the unions and to carry out the detail of the act. A trade union or any branch of a trade union can register as an industrial union. An industrial association is a union of unions, such as trade councils. As a bait to trade unions to enroll as industrial unions, every union or association is given the power to sue its individual members, a power not hitherto possessed by a trade union.

After these preliminaries the bill goes on to define the machinery by which arbitration and conciliation are to be obtained. For this purpose the country is to be divided into industrial districts which will probably be grouped round the populous centres. The Registrar of Friendly Societies is to be represented in each district by a deputy called the Clerk of Awards, who is to carry out the detail of the act. In every industrial district the industrial unions of employers and employed are to elect, in equal proportion, a district board of conciliation. This board is to consist of not more than six and not less than four members, and these are to elect a chairman from outside, who is to have a casting vote only. The details of the method by which the industrial unions are to elect their representatives are not very clearly set out, but probably a supplementary set of rules will be issued regulating this and the method of voting. These boards are to hold office for three years, and are to have power to arbitrate in all industrial questions brought before them either by a single employer or by a union of employed. An important proviso is that no strike or lock-out on account of a trade dispute may take place while that dispute is under arbitration before a board of conciliation. If any industrial district neglect or otherwise fail to elect its board of conciliation, power is given to the governor, who, of course, acts on the advice of the Minister of Labor, to nominate a board, and power is also given to create special temporary boards in non industrial districts for special purposes. Industrial disputes can be referred to the board of conciliation on the application of either party, and the second party is then bound to submit to the court, or judgment goes by default.

Above the boards of conciliation, as an ultimate court of appeal, is the court of arbitration, which acts for the whole country. The court is to consist of three members, one of whom, the president of the court, must be either a judge of the Supreme Court or a district judge. The other two members are to be chosen by the governor, one from the nominations made by the industrial unions of employers and one from those made by the industrial unions of employed. The governor, of course, selects on the advice of the Minister of Labor, in whose hands the constitution of the court thus practically rests. The court is to be re-elected every three years, and is to deal with all industrial disputes referred to it from boards of conciliation. Such disputes may be referred by the board itself or by either party to the dispute. The court may hear evidence as it thinks necessary, and the award in every case must be given within a month after the court has begun its sitting in that case, and it may make this award compulsory or not as it chooses. If the award is to be compulsory it is filed and then ranks as an order of the Supreme Court, but no award is to extend over a period of more than two years.

The main features of this bill seem to be these: That employers are dealt with singly as individuals, while the employed are only recognized in a corporate capacity in industrial unions. No single workman has power to put the act in motion—a fact which practically raises the trade union or industrial union into a third court which has to review the case before it is submitted to the Board of Conciliation. For if a single workman, or, indeed, say the workers in a shop dispute with their master, they are powerless to refer their quarrel to the board unless the trade union or the industrial union to which they belong agrees to do so. Hence the union has to hold a preliminary inquiry. By this means, together with the new power given to unions to sue their members, the trade unions get a stronger position under this act. The only sense in which the arbitration under the act can be said to be compulsory is that if one party refers to either a board or to the court the other is obliged to appear. It is difficult to predict anything as to the future of the bill. Mr. Reeves, the Minister of Labor, declares that 90 per cent. of the industrial disputes of the colony will be settled under it. Captain Russell, however, who is the leader of the opposition and in no sense hostile to the bill, regards it as a purely theoretical measure, which will rarely, if ever, be brought into action.—*Correspondent London Times.*

THE LOCOMOTIVE "PLANET."

WE are again indebted to Mr. Clement E. Stretton for the drawing, from which the engraving herewith has been made, of the *Planet*, built by R. Stephenson & Co., built for the Liverpool & Manchester Line in 1830, and was first put to work in October 30 of that year. Of this engine Mr. Stretton says, in his excellent little book on the locomotive and its development, that it—the *Planet*—was a striking improvement upon all Stephenson's previous ones. The cylinders were placed "inside" under the smoke-box, the driving-wheels were placed at the trailing end of the engine, and a double-cranked axle was employed similar in every respect to one of those previously used for coupling the engine of 1815. The dimensions were as follows:

Cylinders	11 in. diam.
"	16 " stroke.
Between centres of cylinders	2 ft. 6¾ in.
Leading-wheels	3 ft. diam.
Driving "	5 " "
Boiler	6 " 6 in. long.
"	3 " diam.
"	129 tubes 1⅝ in. diam.
Heating surface of tubes	370.41 sq. ft.
" " " fire-box	37.25 " "
" " " total	407.66 " "
Area of fire-grate	6.50 " "
Weight in working trim	8 tons.
" on driving-wheels	8 " 2 cwt. 2 qrs.

This engine had also the usual four-wheeled tender, which weighed 4 tons fully loaded.

On November 23, 1830, the *Planet* worked a special train to convey voters from Manchester to Liverpool for an election; the official report states that "the time of setting out was delayed, rendering it necessary to use extraordinary despatch in order to convey the voters to Liverpool in time." The journey was performed in 60 minutes, including a stop of 2 minutes on the road for water.

On Saturday, December 4, 1830, the *Planet* drew a mixed train of passengers and goods weighing 76 tons (exclusive of the weight of the engine and tender) from Liverpool to Man-

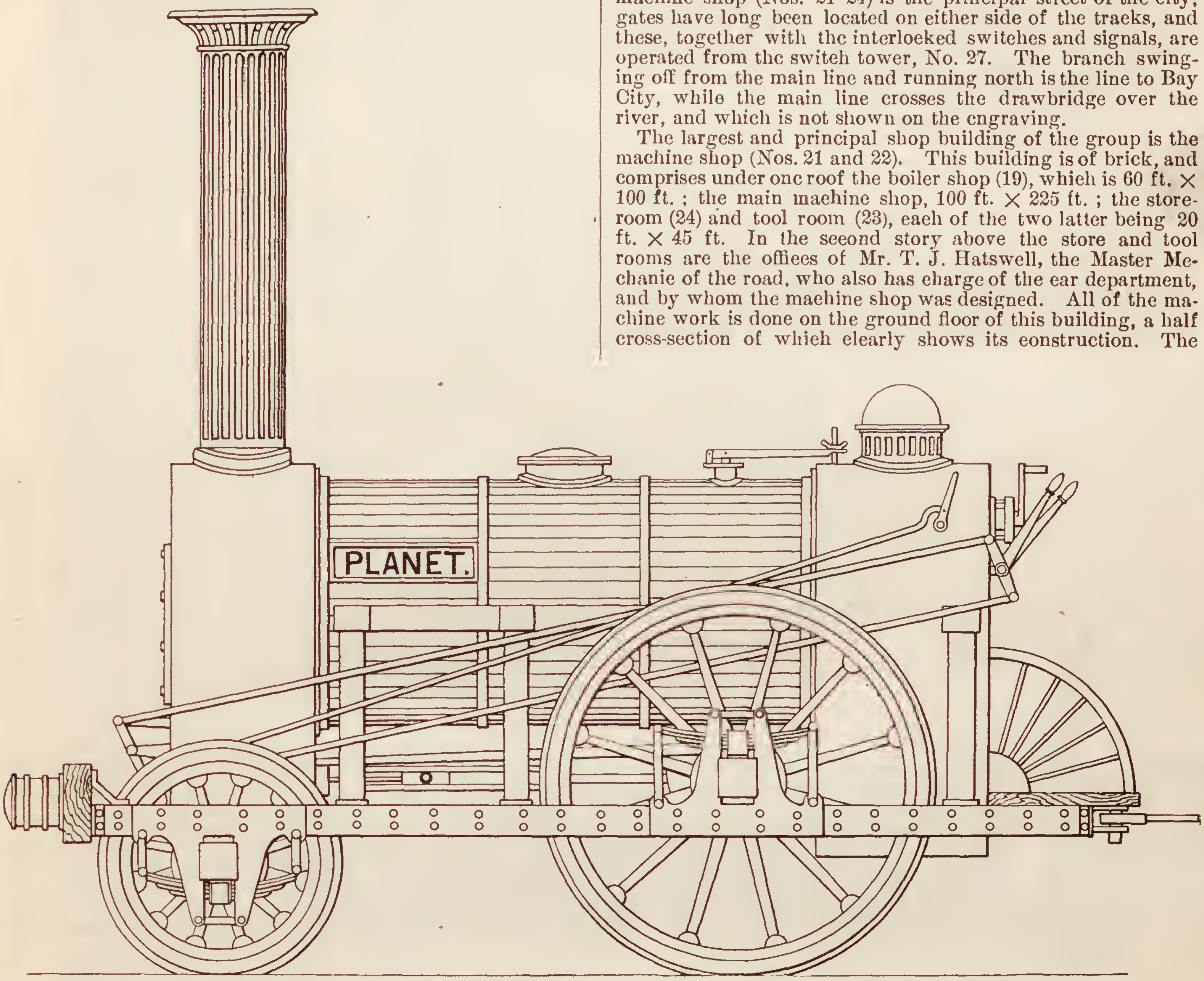
chester in 2 hours and 54 minutes, including three stoppages of 5 minutes each for water and oiling. This train ran at a rate of 16½ miles an hour down the Sutton decline, and its greatest speed on the level was 15½ miles an hour.

From another official report it is found that between September 16 and December 7, 1830, the company's engines conveyed 50,000 passengers, and ran a distance of 28,620 miles, or 954 trips between Liverpool and Manchester and back.

Another engine, called the *Majestic*, was built by the same firm and of the same dimensions as the *Planet*. These were the first locomotives which had cranked axles and inside cylinders.

left-hand edge of the engraving, and the top of the same is toward the north. No. 28 on the engraving is the coaling shed. This consists of a trestle upon which the loaded cars are run and where they are dumped into hoppers beneath the rails; the engines to be coaled are run in on the track shown at the right of the shed, to which communication is obtained by the tracks as shown. Nos. 16 and 17 are brick roundhouses—it being the intention to complete the circle of No. 17 at some future time. Nos. 5 and 18 are water tanks; the former being well elevated so as to supply a pressure sufficient to carry water to the upper stories of any of the buildings on the company's premises. As the street running along the left of the machine shop (Nos. 21–24) is the principal street of the city, gates have long been located on either side of the tracks, and these, together with the interlocked switches and signals, are operated from the switch tower, No. 27. The branch swinging off from the main line and running north is the line to Bay City, while the main line crosses the drawbridge over the river, and which is not shown on the engraving.

The largest and principal shop building of the group is the machine shop (Nos. 21 and 22). This building is of brick, and comprises under one roof the boiler shop (19), which is 60 ft. × 100 ft.; the main machine shop, 100 ft. × 225 ft.; the store-room (24) and tool room (23), each of the two latter being 20 ft. × 45 ft. In the second story above the store and tool rooms are the offices of Mr. T. J. Hatswell, the Master Mechanic of the road, who also has charge of the car department, and by whom the machine shop was designed. All of the machine work is done on the ground floor of this building, a half cross-section of which clearly shows its construction. The



THE LOCOMOTIVE "PLANET," BUILT BY R. STEPHENSON & CO., IN 1830, FOR THE LIVERPOOL & MANCHESTER LINE.

THE FLINT & PÈRE MARQUETTE SHOPS AND PASSENGER STATION AT SAGINAW, E. S., MICH.

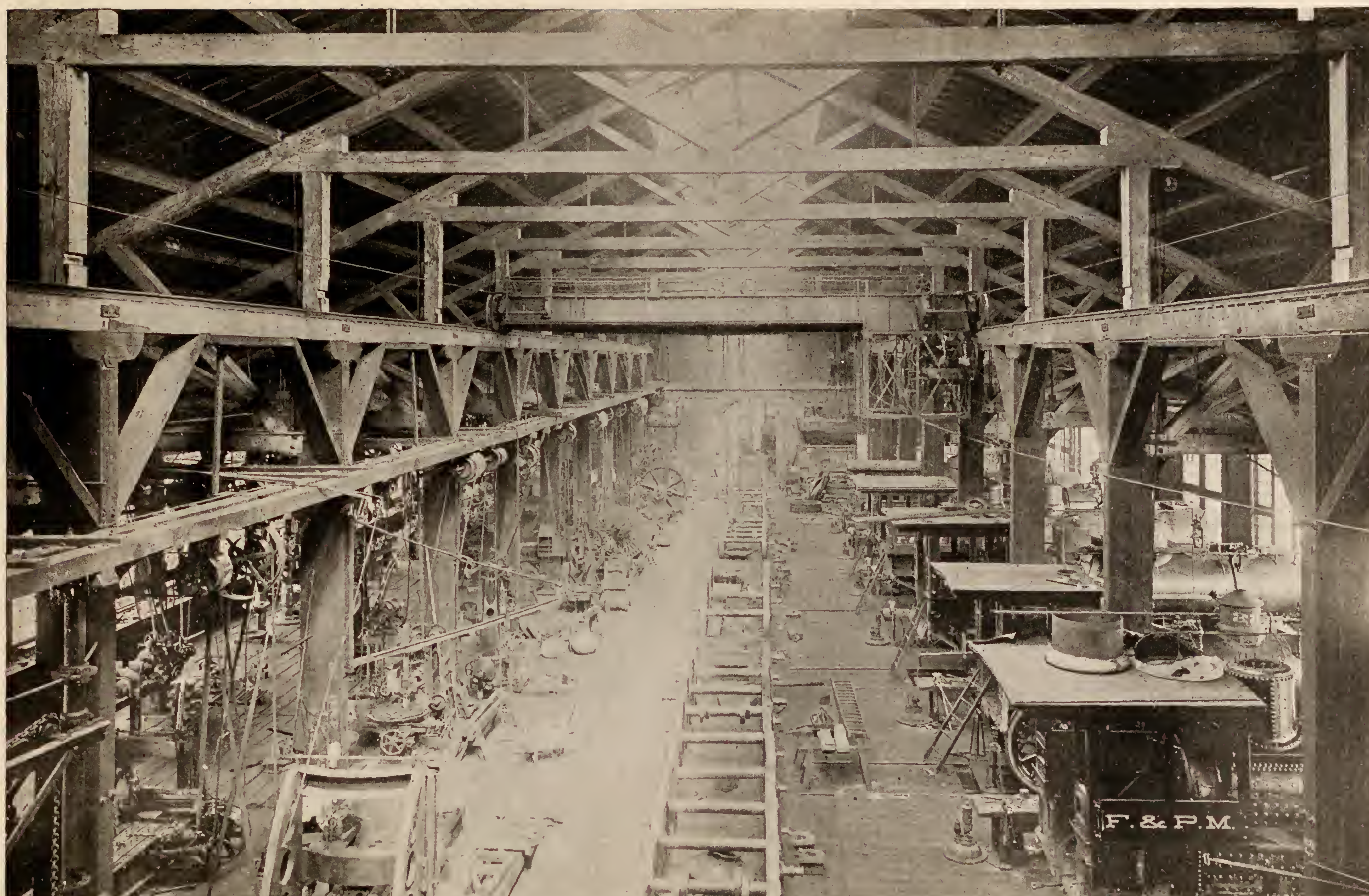
Travellers who have occasion to go north from Detroit into the lumber regions of the southern peninsula of Michigan, or across the State to the Lake Michigan shore, know that the locomotives and cars of the Flint & Père Marquette Railroad are noted for their cleanliness and comfort and the high standard of efficiency that is maintained in repairs. While the road does not rank with the great trunk lines in the magnitude or frequency of its service, that service which it does render is strictly first class. The headquarters are at Saginaw, E. S., formerly East Saginaw, about 20 miles from the mouth of the Saginaw River, and 125 miles from Detroit. The shops are located across the tracks from the city depot, and their arrangement is clearly shown by the accompanying plan. Like nearly all of the railroad shops of the country, these have grown from small beginnings, and the arrangement is not, perhaps, what would be made were they to be wiped out and rebuilt out of whole cloth.

The Saginaw River flows along what is represented by the

tool room is equipped with a universal milling machine, a universal grinder, and a 16-in. swing tool-room lathe with an 8 ft. bed. Here are also kept such tools as a portable cylinder boring machine, a portable valve facing machine, portable drills and Stow flexible shafts for driving them, and drilling and tapping for stay-bolts.

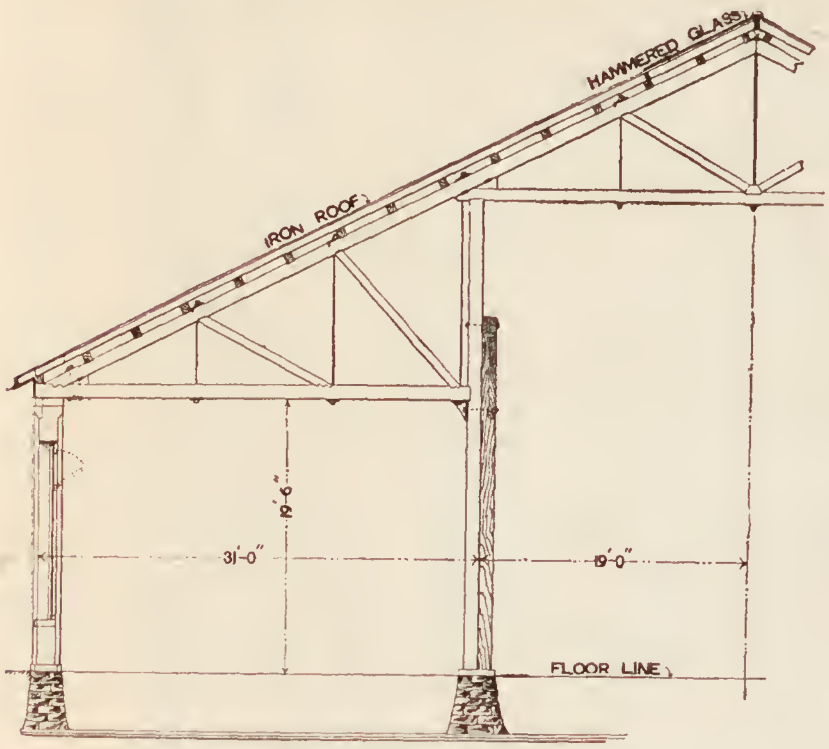
The large machine shop impresses one at once as being remarkably well arranged and convenient. Extending along the whole western side of the shop there is a bench which is furnished with the usual equipment of vises and drawers. Under this same bay there are the small tools, such as lathes, planers, shapers, etc., which are provided and served as the necessities of the work done upon them may require, with suitable light cranes and hoists. The heavier tools, such as the large planers, upon which frames and cylinders are fitted, a heavy universal drill, squaring machine, wheel lathes, boring mill and hydraulic press, stand just outside the bay and under the monitor roof, and are served by a travelling crane spanning the space and running over the rails laid on the special bent provided therefor. This crane has a capacity of 10 tons.

The bay opposite that occupied by the machine tools is given over to the pits, of which there are nine running into



INTERIOR OF THE FLINT & PÈRE MARQUETTE RAILROAD MACHINE SHOP, AT SAGINAW, E. S., MICH. DESIGNED AND BUILT BY MR. T. J. HATSWELL, M.M.

the machine shop and two into the boiler shop. The tracks over the pits run back far enough so that the travelling crane



CROSS-SECTION OF MACHINE SHOP, FLINT & PÈRE MARQUETTE RAILROAD.

can be used to raise the back end of the engines or to carry a cab from the painting platform and place it in position.

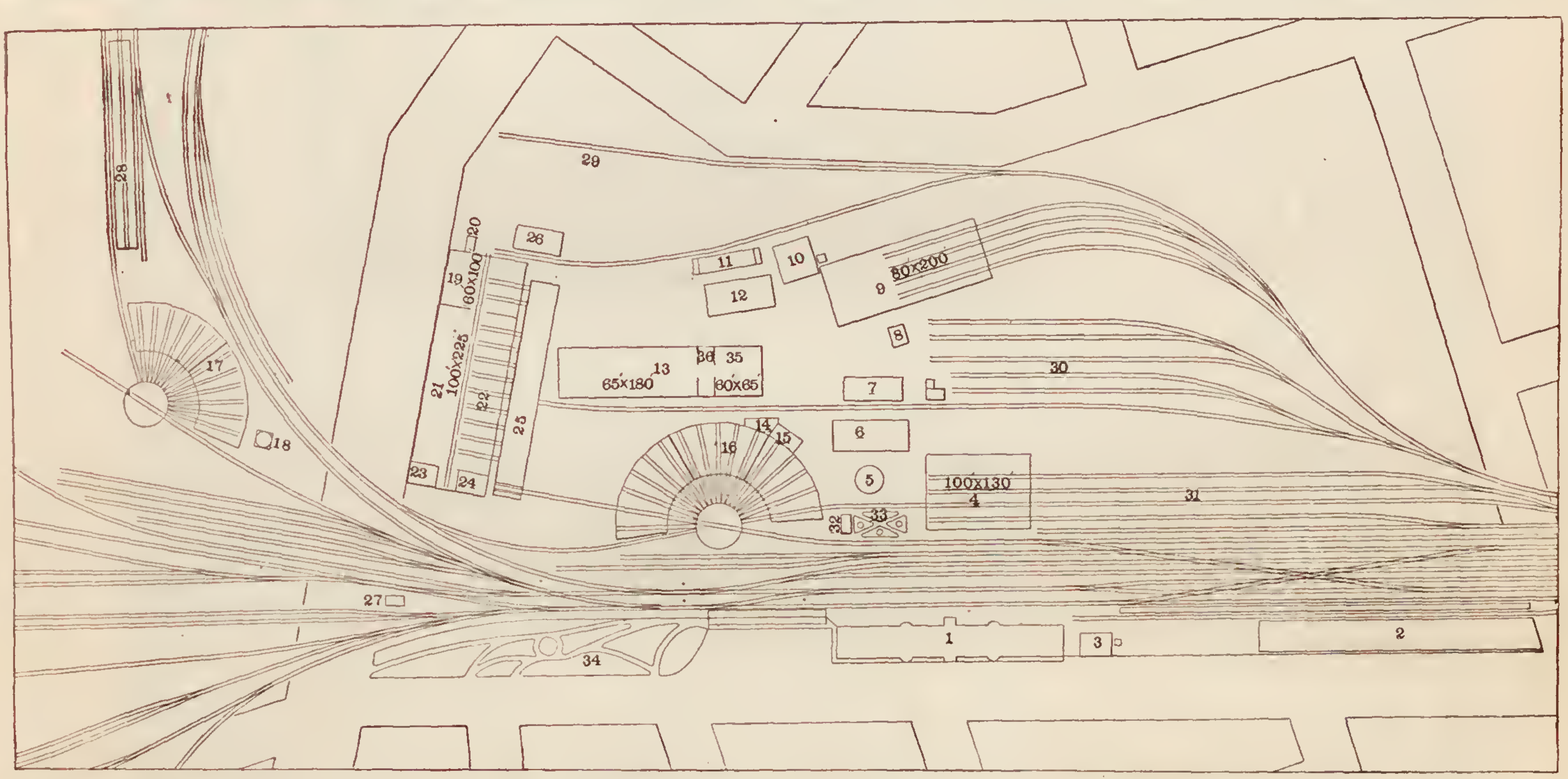
A transfer table travels in the pit (25) along the east side of the building. The boiler shop is also provided with a travelling crane, but this is operated by hand and is of 10 tons capacity, which is quite sufficient to handle any work that has yet come in. The motive power of the road now consists of 93 standard gauge locomotives and 10 for narrow-gauge tracks. All of the repairs for these engines, as well as that for the four steamers of the company that ply between Ludington, Mich., and Milwaukee, Wis., are done in these shops.

No. 13 is the blacksmith shop, also built of brick—a large, well-ventilated room 65 ft. × 180 ft.—and is equipped with a 5,000-lbs. steam hammer and furnace wherewith the company utilizes a large portion of its scrap in manufacturing all of its passenger-car and driving axles, crank-pins, piston rods and engine frames, as well as the other miscellaneous forgings used about its locomotives. And just here it will be interesting to follow the process of making crank-pins. Selected scrap is first piled on shingles, and, after heating, is hammered into slabs; these are reheated, welded and worked into shape. The pins are then turned and case-hardened on the bearing surfaces, after which they are ground true and then pressed into the wheel. A pin made in this way simply does not wear out, but stands up to its work for years.

The blacksmith shop is also provided with two other steam hammers, one of 2,400 lbs. for ordinary work, and one of 1,200 lbs. for light work. A small heating furnace for bolts, with a bolt header, are also among the tools of this shop, it having been found more economical to manufacture all bolts used about cars and locomotives than it is to purchase them.

Just beyond the blacksmith shop, and under the same roof with it, are the store rooms for iron (36) and the bolt and axle shop (35). The latter room is 60 ft. × 65 ft., and is equipped with a number of bolt cutters, double-headed axle lathes, wheel borers, and heavy cutting-off and centring machine that is used for the engine and car axles hammered out in the blacksmith shop. The coppersmith and tin shop is located over the wheel and axle shop.

As we have already said, and as it readily appears from the engraving, No. 16 is the engine roundhouse, and is provided with pits that are steam-heated in winter and thoroughly equipped with water pipes that lead from a pump which delivers water for washing purposes. Nos. 14 and 15 are little excrescences on the roundhouse, the former being the brass foundry and the latter a small roundhouse machine shop. No. 32 is a little room occupied by the Union News Company, and 33 and 34 are small vacant spaces laid out into flower gardens and walks, and instead of being an eyesore to the public in the shape of a waste of cinders, are very attractive. No. 5 is the larger water tank of the two, having a capacity of 145,000 galls., while No. 18 has a capacity of 115,000 galls. No. 4 is a paint shop, a wooden structure 100 ft. × 130 ft., connected by tracks leading into and through from the yard. No. 6 is a storehouse; No. 7 a casting shed for the car depart-



1. Passenger Depot.
2. Freight Depot.
3. Train Master's Office.
4. Paint Shop.
5. Water Tank.
6. Supply Store.
7. Car Department Casting House.
8. Office of General Foreman of Car Shop.
9. Car Shop.
10. Boiler House.
11. Dry Kiln.
12. Warehouse.
13. Blacksmith Shop.
14. Brass Foundry.
15. Round House Machine Shop.
16. Round House.
17. " "
18. Water Tank.
19. Boiler Shop.
20. Flue Cleaning House.
21. Machine Shop.
22. Erecting Shop.
23. Tool Room.
24. Store Room.
25. Transfer Table.
26. Machine Shop Casting House.
27. Switch Tower.
28. Coal Shed.
29. Lumber Yard.
30. Freight Car Repair Yard.
31. Coach Yard.
32. Union News Co.
33. Park.
34. "
35. Car Wheel and Axle Shop.
36. Iron Room.

PLAN OF THE FLINT & PÈRE MARQUETTE RAILROAD YARDS AT SAGINAW, E. S., MICH.

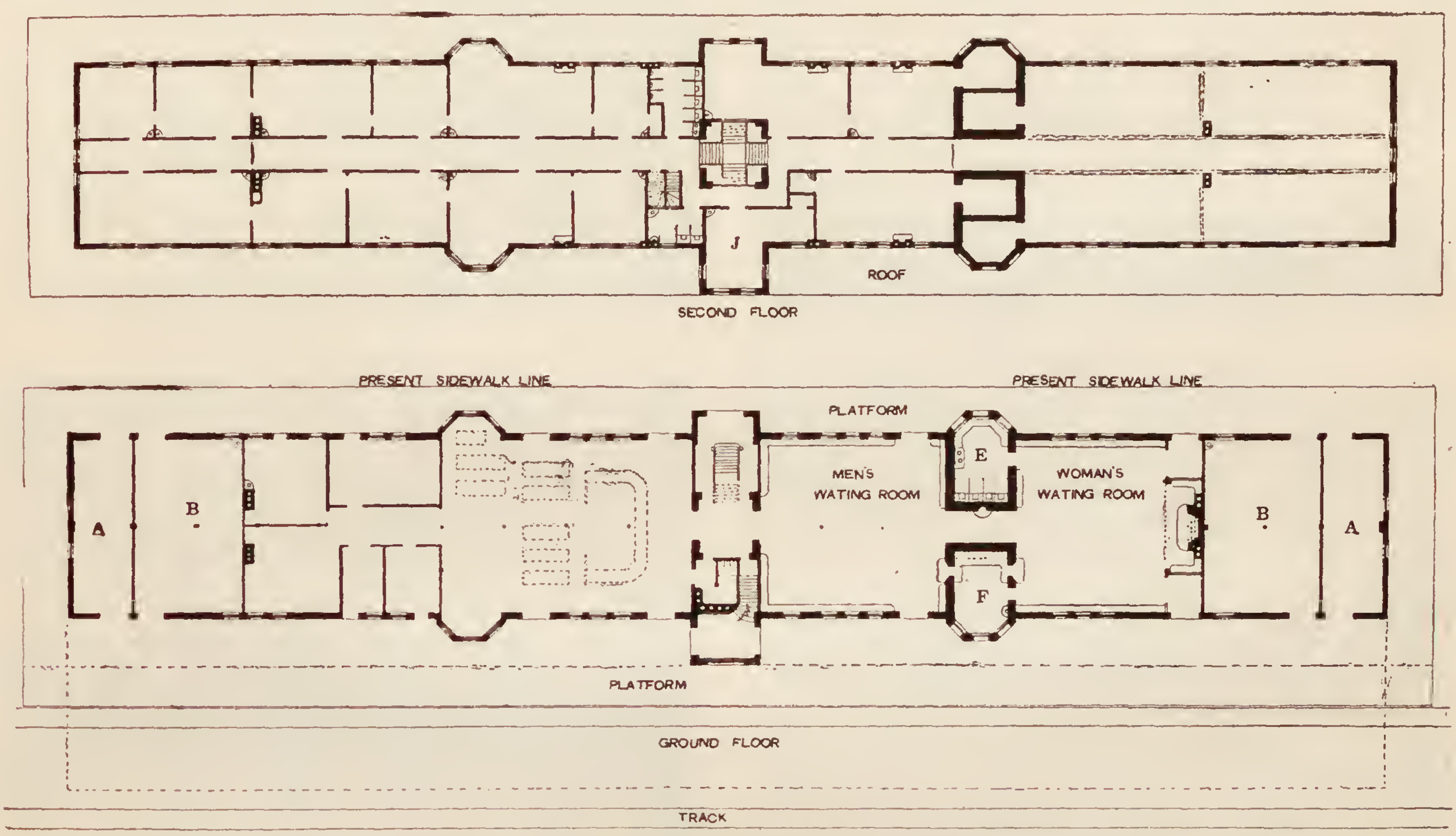
PASSENGER STATION OF THE FLINT & PÈRE MARQUETTE RAILROAD, AT SAGINAW, E. S., MICH. DESIGNED BY BRADFORD L. GILBERT.

ment; No. 26 the casting shed for the machine shops; No. 8 is the office of the general foremen of the car shops, and No. 30 the bone yard and where the rough out-door repairs are done to freight cars.

No 9 is the car shops, a wooden building 80 ft. × 200 ft., one end of which is equipped with the most modern of wood-working tools, while four tracks lead into the other end through wide folding doors. Each of these tracks has a length sufficient to carry four freight cars. No. 10 is the boiler house, where all of the steam used on the premises, with the exception of that required for heating the depot, is generated in four water-tube boilers. A long line of jacketed pipe leads thence to the machine shop, with a branch running over to the blacksmith shop and wheel shops, the connection with the car shops being very short. In all of these buildings there are separate engines; the one in the machine shop drives a line of shafting running the whole length of the shop, from which also the counter-shaft moving the transfer-table obtains its power; the engine in the blacksmith shop drives the fan for the furnaces and the shafting for operating the machinery in the wheel-room; there is also an engine in the roundhouse machine shop and one in the car shop. No. 11 is a dry kiln provided with coils of steam pipe at one end, over which the air passes on its way to the lumber; natural draught is used, and it is obtained by means of a high stack. No. 12 is a warehouse.

doors in the background are the doors leading into the boiler shop; and when a boiler is to be carried to or fro it is picked up by the crane in one shop and taken to the door, where the other takes hold of it and delivers it at its destination

The other full-page engraving represents the passenger depot of the road at Saginaw, East Side. It was built a number of years ago after the designs of Mr. Bradford L. Gilbert, to whom we are indebted for the plans showing the arrangement of the two floors. The building is of red brick, with light sandstone trimmings, with a hood extending out so as to cover the platforms and the sidewalk, enabling passengers arriving from carriages to step into the depot during inclement weather without being wet. The first floor is entirely devoted to the passenger service. The engine and boiler house that appears at the extreme left of the photograph is a separate structure from the main building, and contains the heating apparatus for the station, as well as some store and cleaning rooms for lamps and cars. The rooms marked *A* are for the express; *B* for the baggage; then the rest of the eastern end of the building is devoted to the kitchens and restaurant, which latter is separated from the men's waiting-room by a hallway in which there is now an elevator that is not shown on the plan. Next is the men's waiting-room, separated from the women's by the ticket office and the ladies' toilet. The women's wait-



FLOOR PLANS OF PASSENGER STATION OF THE FLINT & PÈRE MARQUETTE RAILROAD, AT SAGINAW E. S., MICH.

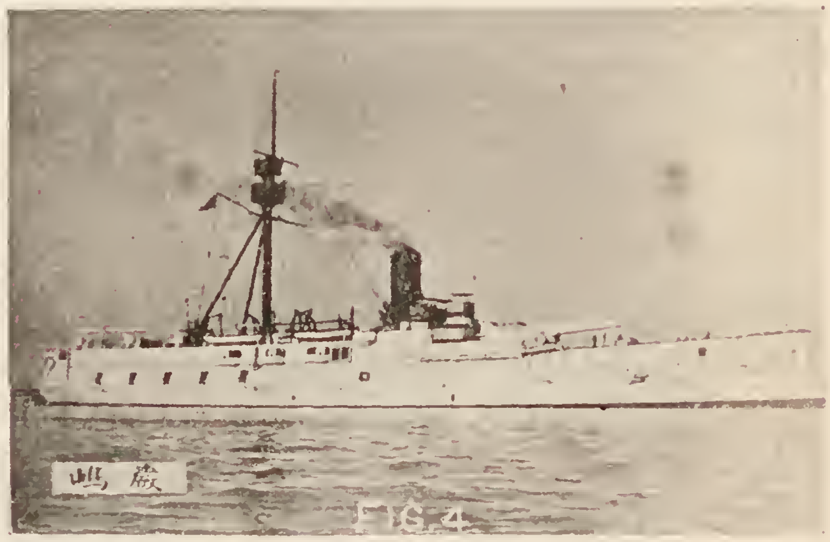
It is very rarely that shops that have grown up as these have done, from the time when the road was very small, with but a few engines to its present proportions, possess that convenience of arrangement that we find here. It is one of the settled principles in the economical handling of material in machine shops that there shall be no doubling back on the movement of work in its progress from start to finish. It will be seen that this principle has been followed and kept steadily in view in the planning of these shops. Material that is intended for the machine shop goes from the blacksmith shop directly to the tool upon which it is to be finished, and on the way it meets nothing that is to be carried in an opposite direction. From the tool in the machine shop it goes straight to the locomotive to which it is to be applied; and this in turn passes from the machine shop to the roundhouse without meeting with any obstacle.

In like manner the work for the car shops goes to the point of application, and in an opposite direction from the machine shop, so that there is no clashing. Labor-saving tools in both places tend to lessen the cost of production; and this was one of the early shops to recognize the economy that would result from the use of a travelling crane. The interior arrangement of the machine shop is very clearly shown by the full-page engraving, wherein the facility with which work can be handled and placed by the crane is well brought out. The large

ing-room is furnished with an exceedingly handsome fireplace of red tiling, and the whole lower floor to which passengers have access is handsomely finished in oak. On the walls of the waiting rooms there are hung, instead of the usual posters, a number of fine engravings that serve to break the monotony of the ordinary type of railway station.

There is little to say in regard to the upper story. It is divided into good-sized rooms, as shown on the plan, that are now occupied as the general offices of the company, although they were not originally designed for that purpose. When the building was erected the general offices were in another building owned by the company and located at some distance from the station, while the offices here were occupied only by the officers of the operating departments. They are arranged in suites in such a way that any two adjoining rooms can be used together for a single department. The despatcher is placed in the room *J* with keyboards along the front and sides. The windows of the bay projecting out on the track-side afford a clear view up and down the tracks, and projecting from the outside wall is the order signal.

In reviewing the whole plan of the yard, one cannot fail to be impressed with the handiness of the arrangements that have been made, and to consider it as remarkably well designed to meet the wants of a road of moderate size in prosperous circumstances like the Flint & Père Marquette.



JAPANESE WAR SHIPS.

A Japanese correspondent has sent us the above photographs of a number of war ships belonging to Japan, engravings of which are given herewith, and which, owing to the war in which that country is engaged, will be of interest to many readers :

Fig. 1 represents the man-of-war *Takachiho*.
" 2 " " " *Naniwa*.
" 3 " " " *Matushima*.
" 4 " " " *Itsukushima*.

Fig. 5 represents the man-of-war *Fuso*.
" 6 " " " *Hiyei*.
" 7 " " torpedo-boat *Kotaka*.
" 8 " a ship of the old style.

TRIPLE-EXPANSION ENGINE FOR THE STEAM YACHT "WAPITI."

The engine published herewith was recently built by F. W. Wheeler & Co., West Bay City, Mich., for the steam yacht *Wapiti*, owned by Mr. Isaac Bearinger, of Saginaw, Mich.

The hull is of steel, schooner rigged and painted white, and presents a very handsome appearance. The general dimensions are: Length on water-line, 75 ft.; beam, 15 ft.; draft of water, 6 ft. She has commodious quarters for owner, guests, and officers, and is elaborately furnished and well lighted by electricity; the entire cabin is finished in mahogany.

The engine is of the inverted, triple-expansion type, with cylinders 9 in. × 14 in. × 23 in. in diameter and a stroke of 14 in., driving a Trout propeller 4 ft. 6 in. in diameter and 6 ft. mean pitch. The cylinders are placed in the sequence of high-pressure, intermediate-pressure, and low-pressure. A very small space fore-and-aft being available for engine room, it was necessary to design an engine as short as possible, and for this reason the valve-chests were placed athwart ships and the low-pressure and intermediate cylinders were cast together in one piece, while the high-pressure and intermediate-cylinder receivers were bolted together. All steam-ports and passages are calculated for a piston speed of 900 ft. per minute.

The ports in the high-pressure cylinders are 1½ in. deep and 6½ in. wide, in the intermediate-pressure cylinder 1⅞ in. deep and 11 in. wide, and the low-pressure cylinder ports are 2½ in. deep and 20 in. wide. The main steam-pipe is 3½ in. in diameter, and the exhaust-pipe leading to the condenser is 8 in. in diameter, both pipes being of copper.

The throttle-valve is of the balanced cylindrical type fitted with a relief-valve. Steam is admitted in the middle of the high-pressure valve to the high-pressure cylinder, and exhausts at both ends into a receiver connected with the middle of the intermediate-pressure valve, from which it exhausts at both ends into the low-pressure valve in the usual way, the exhaust this time being carried by the inside of the valve to the condenser. All the cylinders are fitted with piston-valves, and the ports in all valve-chests are 1¾ in. deep.

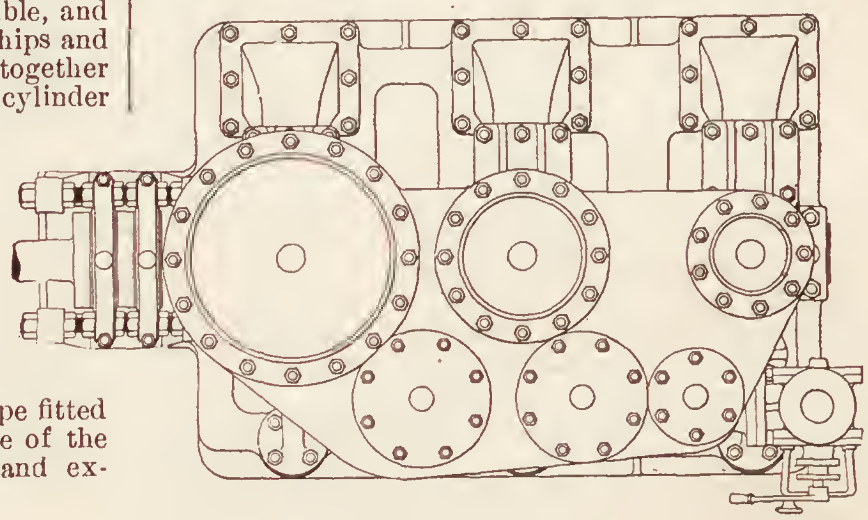
The high-pressure valve is 5½ in. in diameter of the "Heyde" patent type, with a lap of 1 3/16 in. at top and ⅞ in. on bottom. The intermediate valve is also of the "Heyde" type, and is 9 in. diameter with the same laps as the high-pressure. The ports in the valve-chamber extend only half around, and the valve is kept absolutely steam-tight by the half circular spring ring on the opposite side of the ports pressing the valve against the liner, the other half of the ring being pinned to the valve making a solid plug-valve. This valve combines the advantages of a steam-tight flat D-valve and a perfectly balanced piston-valve into one, and is patented by Mr. Edward Heyde, M.E., with Wickes Brothers, of Saginaw, Mich.

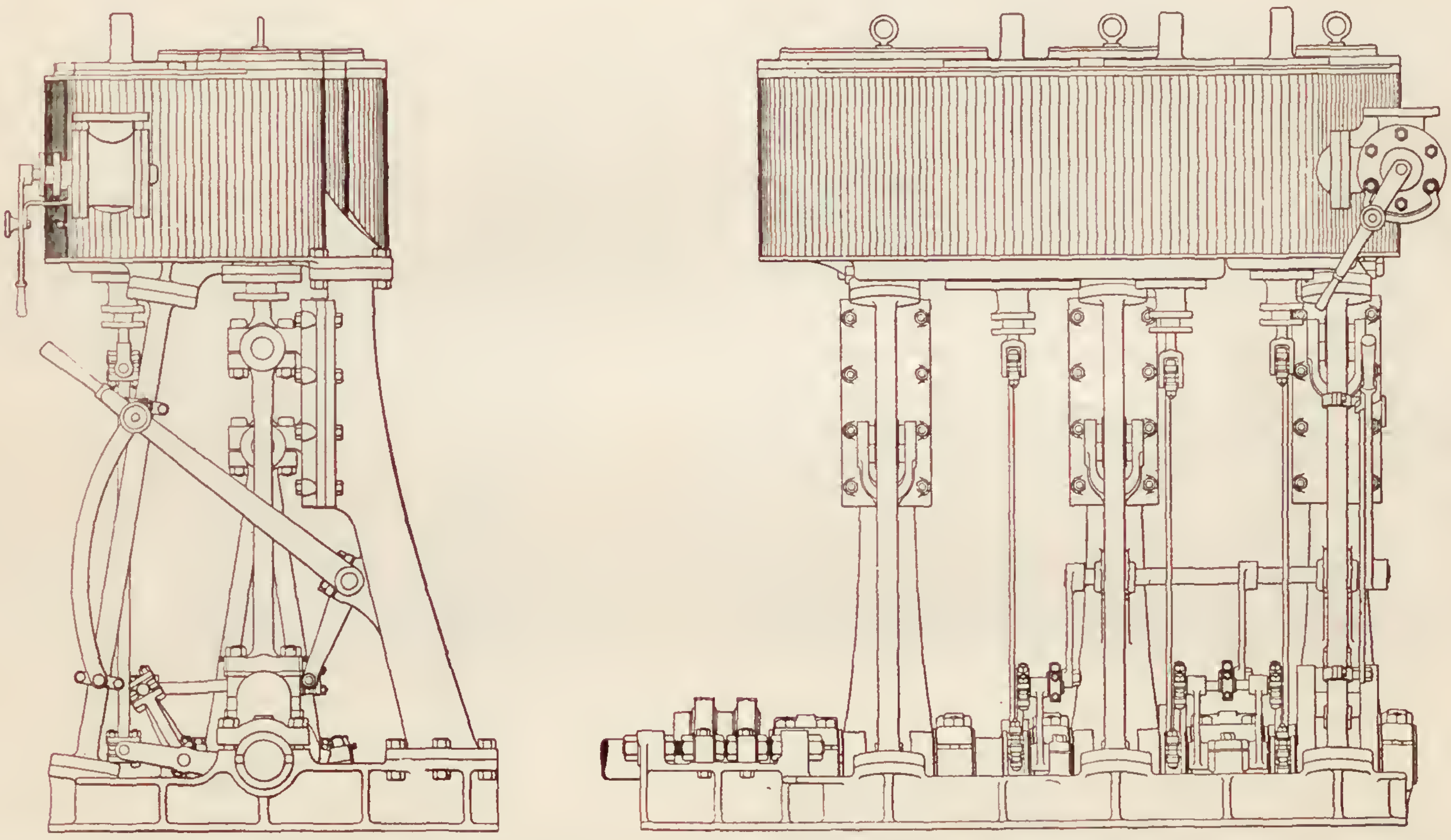
We wish to call especial attention to the Heyde valve that is used on this engine, and of which we present a separate engraving, although the latter does not illustrate the valve that is used on this particular engine. The great trouble that has heretofore been experienced with this type of valve lay in the fact that the rings were apt to catch in the ports if they were allowed to travel over them, and that the wear resulted in bad leakages of steam past the packing. With this arrangement it will be seen that the bottom face of the valve is kept solid, and that the rings merely stand out on the back to serve as balancing packing, and that if they were removed the valve would work on as usual with the exception that it would no longer be balanced.

The low-pressure valve is 10 in. in diameter, fitted with a self-setting spring ring and having ⅞ in. lap on both ends. All valves are worked by the Marshall radial valve-gear, all connections being made adjustable. Steam is cut off in all cylinders at 0.75 stroke when in full gear. All valve-stems are of steel, the high-pressure and intermediate-pressure being 1⅛ in. in diameter, and the low-pressure 1¼ in. in diameter.

The eccentrics are forged solid on the crank-shaft, and the straps are of wrought iron lined with babbit metal. All pistons are of cast iron of the same weight 3 in. deep and fitted with self-setting spring rings; they are securely fastened to piston-rods by means of quick taper and nuts. The piston-rods are made of the very best mild steel 1⅞ in. in diameter for the high-pressure and intermediate-pressure, and 2 in. in diameter for the low-pressure.

The crossheads and piston-rods are in one piece, free from welds, and the slippers are provided with brass gibs 9½ in. deep and 6½ in. wide, the gudgeons being 2½ in. in diameter by

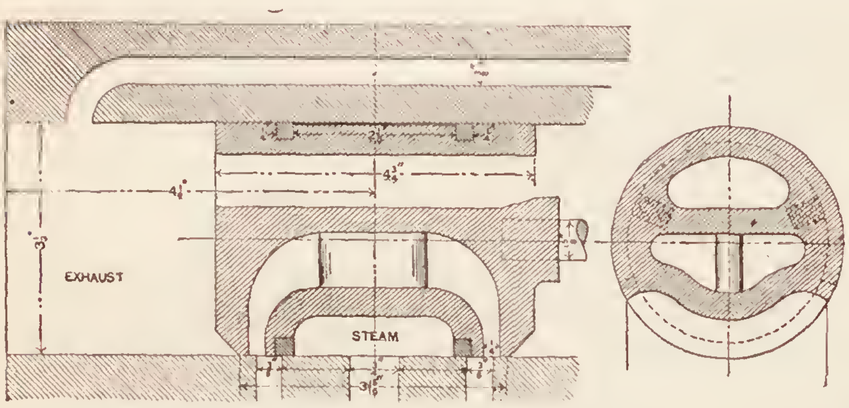




TRIPLE-EXPANSION ENGINE FOR THE STEAM YACHT "WAPITI," BUILT BY F. W. WHEELER & CO., WEST BAY CITY, MICH.

4 in. in length. The connecting-rods are also of steel 39 in. between centres, with the upper end forked. The diameter at the upper end is 1⅞ in. and 2¼ in. at the lower. The bolts in the crosshead are 1⅛ in. in diameter, and the connecting-rod bolts are 1¼ in. in diameter, all being of steel. The crank-pin brasses and all main journals are lined with Magnolia anti-friction metal.

The cylinders and valve-chests are covered with magnesia and lagged with highly polished mahogany. They are supported by three wrought-iron columns in front, leaving the



HEYDE'S PISTON VALVE.

entire front of the engine open for examination of the journals, and by three cast-iron columns in the rear, the latter forming the guides, which are of the slipper-slide variety.

The bed-plate is of the girder type, with the thrust bearing cast on, and has five main journals. The crank-shaft is forged solid of mild steel 4½ in. in diameter, with the eccentric and thrust collars forged on. The crank arms are 2 in. thick for the high-pressure, 2¼ in. for intermediate-pressure, and 2½ in. for low-pressure, with a common width of 6 in. The cranks are placed 120° apart, with the intermediate leading the high-pressure, and the low-pressure crank following. The two thrust collars are 10½ in. in diameter, and 1¾ in. in thickness. The horseshoes are faced with babbit metal, and are adjustable by means of steel bolts and brass nuts.

The condenser is of the independent, single-acting type, with a steam-cylinder 7 in. in diameter, water and air-cylinder 12 in., and a stroke of 12 in. weighing only 2,000 lbs., and of an entirely new pattern, made by the Dean Brothers Steam Pump Works, of Indianapolis, Ind.

Steam is furnished by a 7 ft. × 8½ ft. Roberts' water-tube boiler. At the working pressure of 200 lbs. per square inch the engine is expected to develop a maximum of 400 I.H.P. when making 400 revolutions per minute, and to maintain a calculated average speed of the vessel of 17 statute miles per hour. The engine was designed by S. Anderson, M.E., with F. W. Wheeler & Co.

SOME TESTS RELATIVE TO THE PRODUCTION OF STEAM.*

By Eduard Sauvage.

Experiments with Tubes of Varying Lengths and Diameters and of Different Kinds.—The experiments made by the Paris, Lyons & Mediterranean Railway Company, under the direction of the late A. Henry, furnish accurate data regarding the effect of the system of tubes used in boilers. The experiments were first carried on with a boiler having a grate with an area of 25.2 sq. ft. and 107.64 sq. ft. of heating surface in the fire-box. It had 185 brass tubes with a diameter of 1.8 in. on the inside and 2 in. on the outside. The length of the tubes that were used were 22 ft. 11½ in., 19 ft. 8¼ in., 16 ft. 4⅞ in., 14 ft. 9⅛ in., 13 ft. 1½ in., 11 ft. 5⅞ in., and 9 ft. 10⅛ in., respectively.

For each length that was tested the work was done with a simple fire-box, then a fire-box with a short brick arch, one with a long brick arch and the Tenbrinck boiler. Finally, each arrangement included three different rates of draft, measured by the differences that were found to exist between

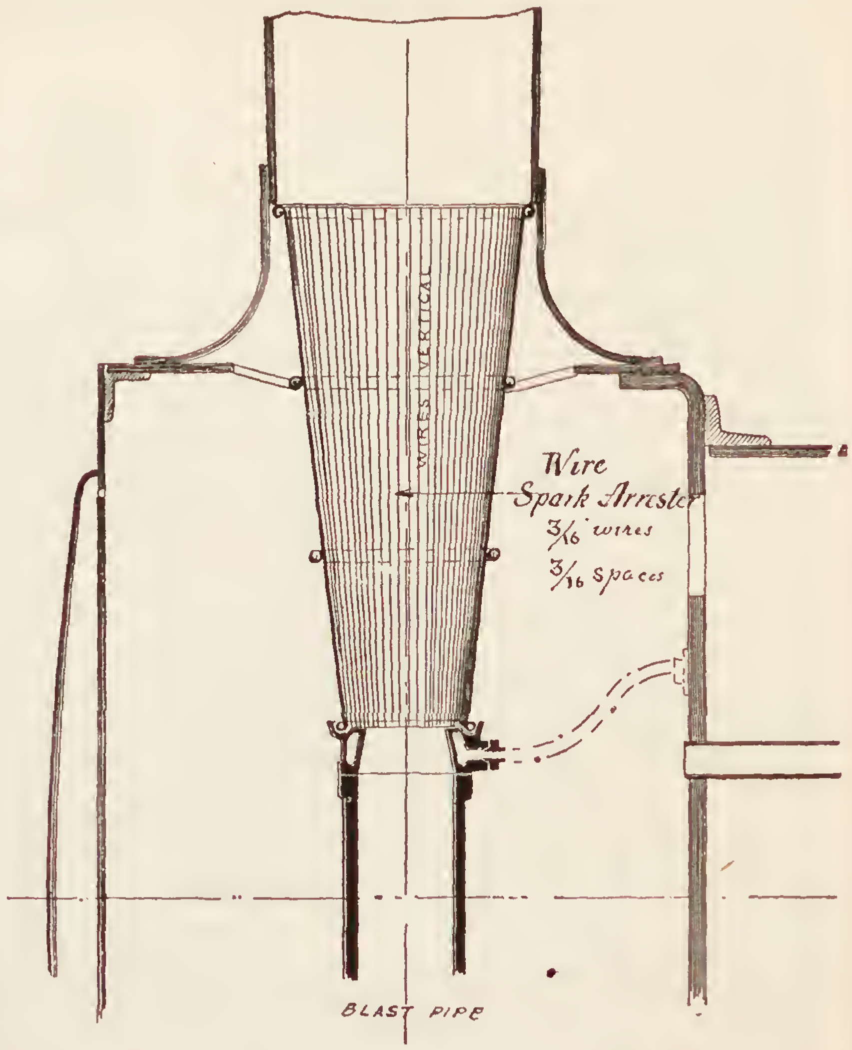


Fig. 1.

SPARK NETTING OF THE GREAT INDIAN PENINSULA RAILWAY.

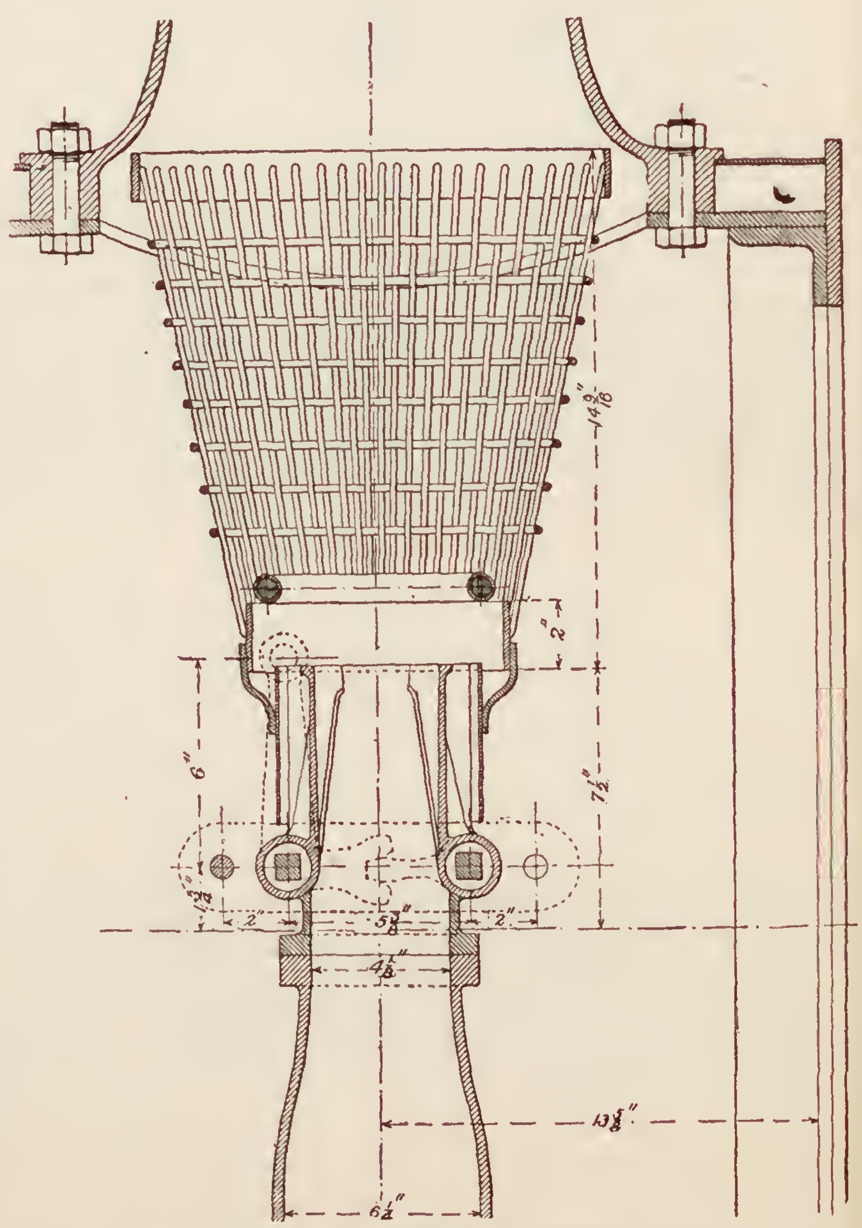


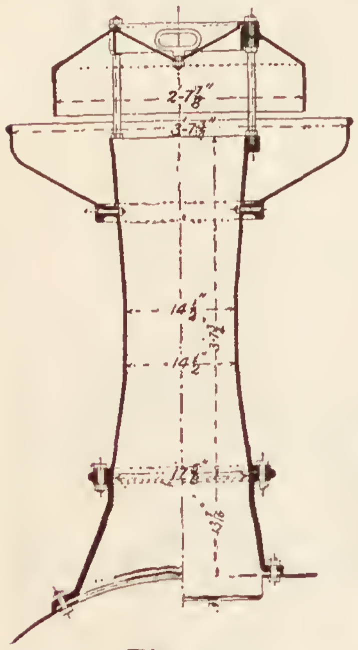
Fig. 2.

SPARK ARRESTER ON THE ROUMANIAN RAILROADS.

* *Bulletin de la Commission Internationale du Congress des Chemins de fer.*

the pressures in the ash-pan and the smoke-box, expressed in the height of a column of water which was 1 in., $1\frac{3}{4}$ in., and 3 in. high, respectively. There were also some complementary tests made by reducing the grate area and the number of tubes to a greater or less degree.

In consequence of this first series of experiments, the work was carried on with boilers having nearly the same fire-box, but with varying tubes, as follows :



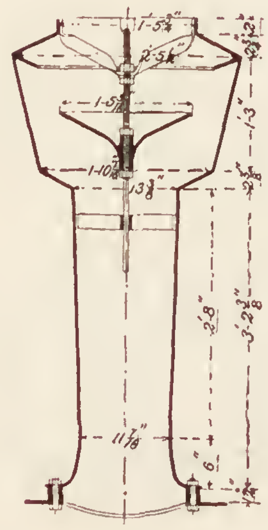
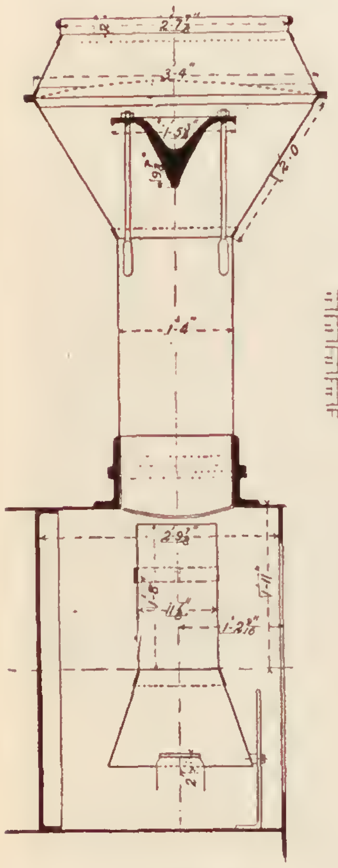
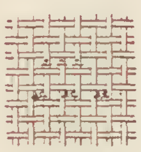


Fig. 3. Fig. 4.

STACKS FOR WOOD AND LIGNITE-BURNING LOCOMOTIVES ON THE ROUMANIAN RAILROADS.





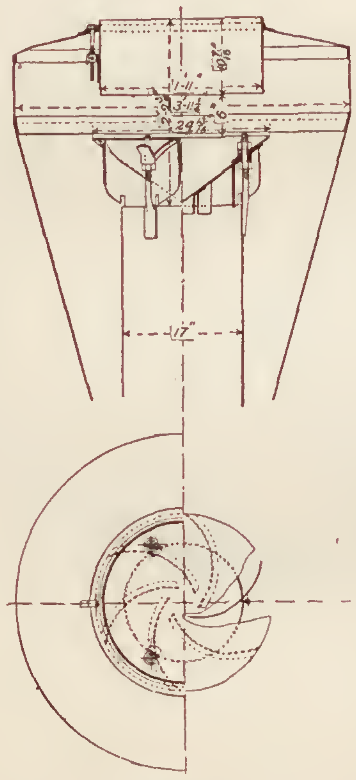


Fig. 5.

STACK FOR LOCOMOTIVES ON THE NORWEGIAN STATE RAILROADS.

Fig. 6.

STACK FOR WOOD-BURNING LOCOMOTIVES ON THE MOSCOW-BREST RAILROAD.

185 tubes of	2	in. outside diameter,	and	13 ft.	$2\frac{7}{8}$	in.	long
224 "	" $1\frac{3}{4}$	"	"	"	" 13 "	$2\frac{7}{8}$	"	"
247 "	" $1\frac{3}{4}$	"	"	"	" 14 "	$3\frac{1}{4}$	"	"
307 "	" $1\frac{9}{16}$	"	"	"	" 14 "	$3\frac{1}{4}$	"	"
247 "	" 2	"	"	"	" 13 "	$7\frac{3}{8}$	"	"
210 "	" $2\frac{3}{16}$	"	"	"	" 13 "	$7\frac{3}{8}$	"	"

These six boilers belonged to compound engines and were made to carry a steam pressure of 225 lbs. per square inch.

A third series of tests was made with the Serve tubes, having at first 185 tubes with a diameter of $1\frac{1}{2}$ in. on the outside, and whose lengths were successively 11 ft. $5\frac{1}{4}$ in., 9 ft. $10\frac{1}{8}$ in., 8 ft. $2\frac{1}{2}$ in., and 6 ft. $6\frac{3}{4}$ in.; then with 113 tubes with an outside diameter of $2\frac{1}{2}$ in. and lengths of 13 ft. $1\frac{1}{2}$ in., 11 ft. $5\frac{1}{4}$ in., 9 ft. $10\frac{1}{8}$ in., 8 ft. $2\frac{1}{2}$ in. All of these experiments were made with a fire-box furnished with a short arch and afterward with a Tenbrinck boiler. The draft corresponded to columns of water having the heights of 1 in., $1\frac{3}{4}$ in., 3 in., 4 in., and $4\frac{3}{4}$ in.

The conclusions that were reached as the result of these numerous experiments can be applied in all of their strictness only to boilers that are similar to those that were experimented upon. But there are many locomotive boilers that are so nearly like them that we can logically apply the conclusions to them, as they do not vary much from the good practice of the Company. It is essential that the fuel should not differ much from the briquettes chosen by the Lyons Company. With these reservations the experiments of the Lyons Company furnish accurate data that is applicable to very many cases.

The experiments have led to the following conclusions: With the ordinary arrangement of tubes, 185 in number, and with a diameter of 2 in. on the outside, the evaporation of the boiler touches its highest point when the length runs from 13 ft. $1\frac{1}{2}$ in. to 14 ft. 9 in., and that the utilization of fuel, naturally less with longer tubes, is nevertheless satisfactory. By reducing the number of tubes the production of steam falls off, but the economical utilization of the fuel remains about the same.

The increase of the diameter of the tubes and the reduction of their number increases the production of steam, by giving

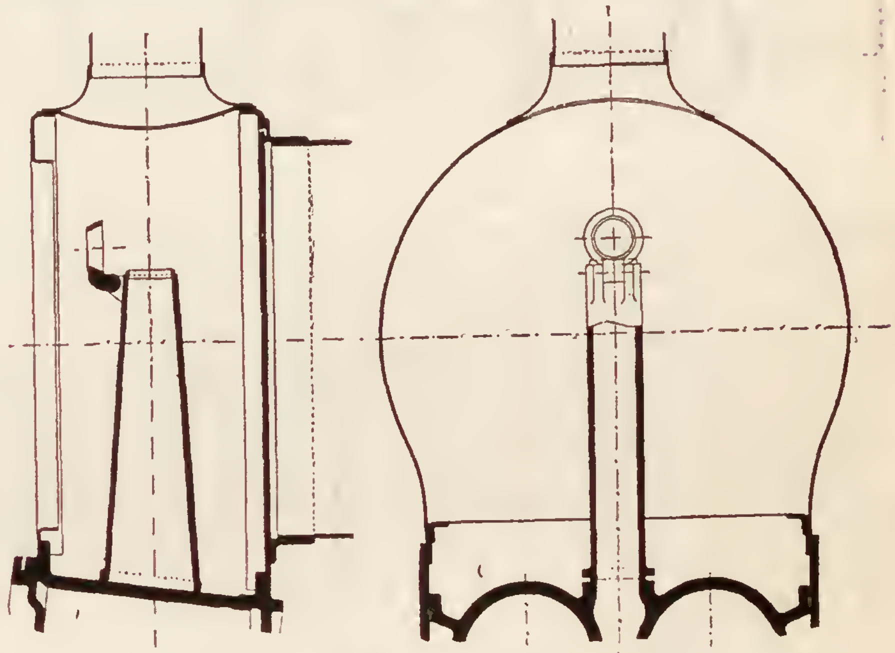


Fig. 7.

THE MacALLAN VARIABLE EXHAUST ON THE GREAT EASTERN RAILWAY.

a larger section for the escape of the products of combustion from the fire. The economical consumption of fuel is reduced when the diameter is increased in consequence of a reduction in the heating surface, but the advantages accruing from a more abundant production of steam justifies the use of tubes ranging in diameter from 2 in. to $2\frac{3}{16}$ in.

The Serve tubes give their maximum production of steam at lengths considerably less than that of the smooth tubes (6 ft. $6\frac{3}{4}$ in. to 8 ft. $2\frac{1}{2}$ in.). It is shown by a comparison of the different results obtained with experiments with the Serve tubes, that it is possible to obtain with them the same evaporative efficiency and the same utilization of the fuel as with the smooth tubes, and at the same time shorten the boiler, thus materially reducing the weight.

Some locomotives on the Northern Railway have been equipped with Serve tubes having an outside diameter of $2\frac{3}{4}$ in., and a length of from 11 ft. $5\frac{1}{4}$ in. to 13 ft. $1\frac{1}{2}$ in. The boilers that have been fitted with these tubes have given good results in service.

In making an application of these tubes to tube-sheets that are already in service, it is possible to reduce the depth of the wings a trifle, and also to shorten them by making the tubes smooth for a part of their length. The experiments of the Northern Railway Company* have shown that, with proportions suitable to the width and the length of the wings, in tubes of 2 in. diameter it is possible to obtain the same evaporative efficiency with a better utilization of the fuel, the draft remaining the same ; the amount of fuel burned per hour diminishes a little, but the amount of water evaporated has been found to remain about the same, which is an evident advantage.

* See American Engineer for June, 1894.

Arrangement of the Tubes in the Boiler.—The tubes are arranged staggered or in vertical rows. The second arrangement is the one that is generally preferred, as it seems to facilitate the disengagement of the steam, and to offer no impediment to the fall of the deposits of solid matter.

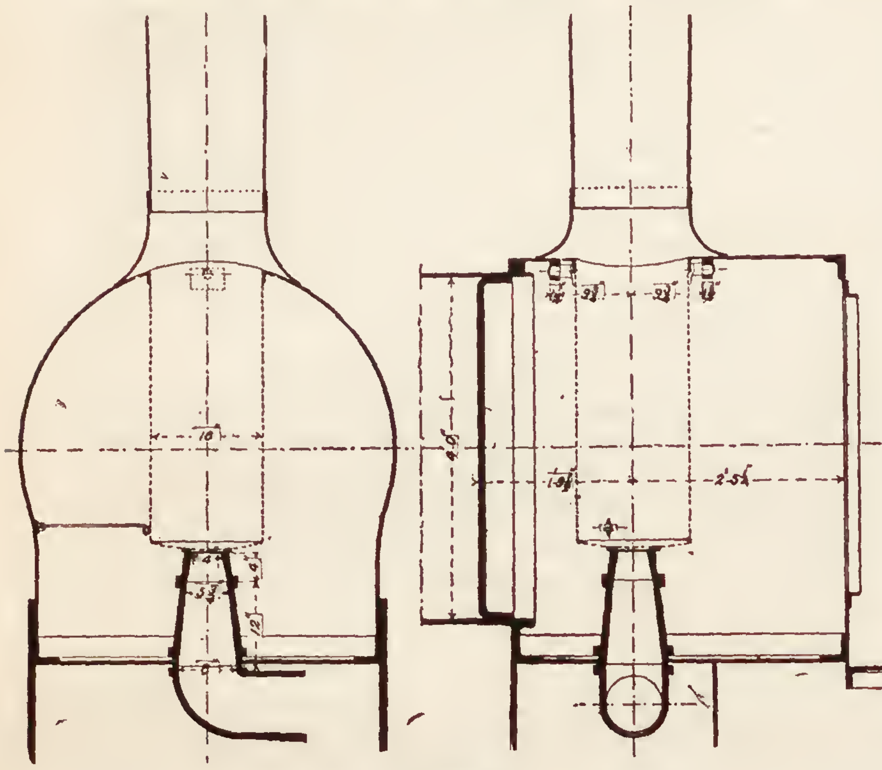


Fig. 8.

SMOKE-BOX AND EXHAUST FOR LOCOMOTIVES ON THE NORWEGIAN STATE RAILROADS.

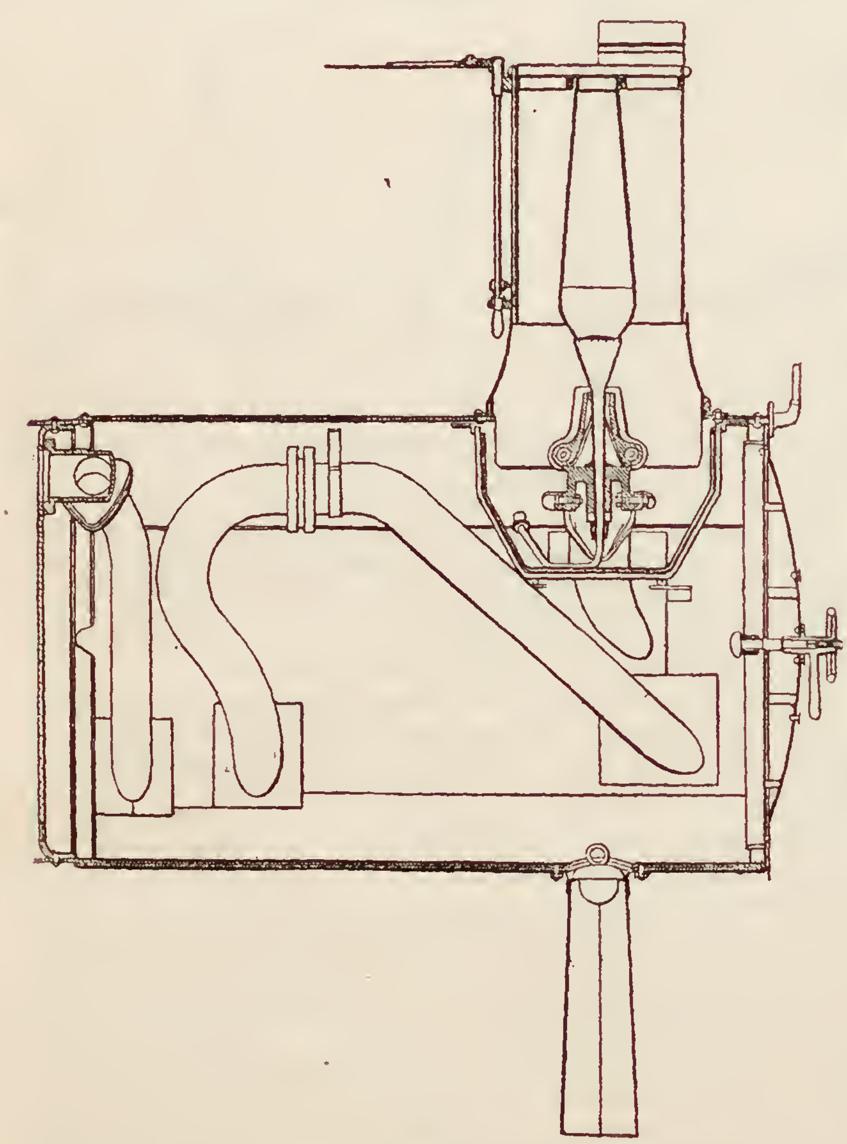


Fig. 9.

SMOKE-BOX FOR COMPOUND LOCOMOTIVES ON THE PARIS, LYONS & MEDITERANIAN RAILROAD.

Influence of the Metal of the Tubes.—In making a theoretical study of the transmission of the heat of hot gases to water, we see that the quantity transmitted depends especially on the coefficient of transmission of the heat from the metal to the water; the difference between the coefficient of conductibility given by brass and iron when we take the thinness of the tubes into consideration has no appreciable effect. The difference in the production of steam, if any exists, that could be attributed to the use of different metals, could only be proven indirectly by the greater thickness of the deposits that are put upon the iron; and this greater thickness has not been demonstrated. In fact, some experiments that were made by the Paris, Lyons & Mediterranean Company, on some boilers

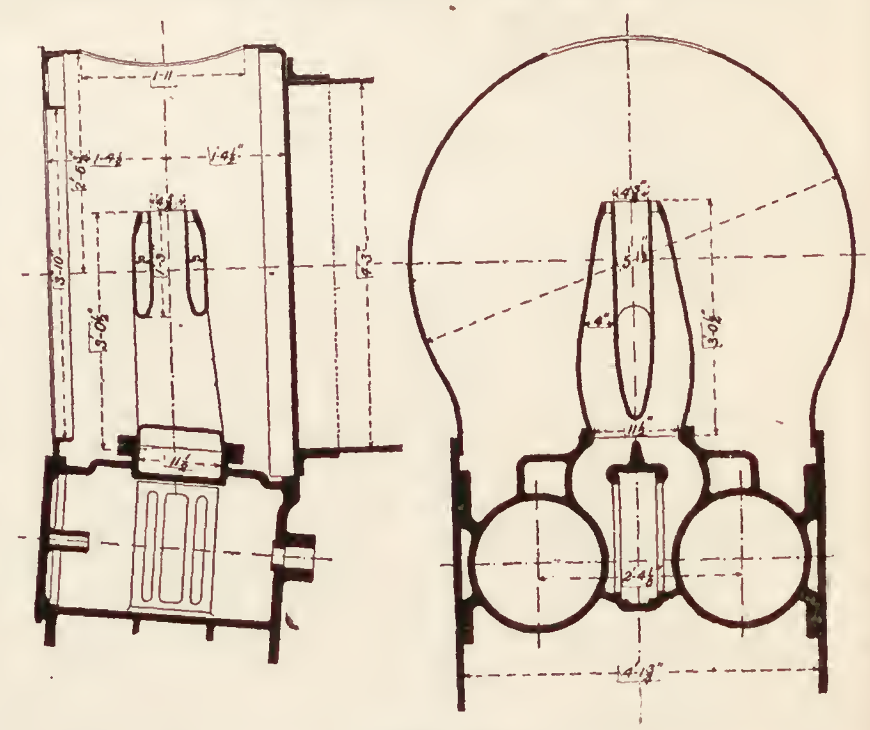


Fig. 10.

THE ADAMS EXHAUST ON THE LONDON & SOUTHWESTERN RAILWAY.

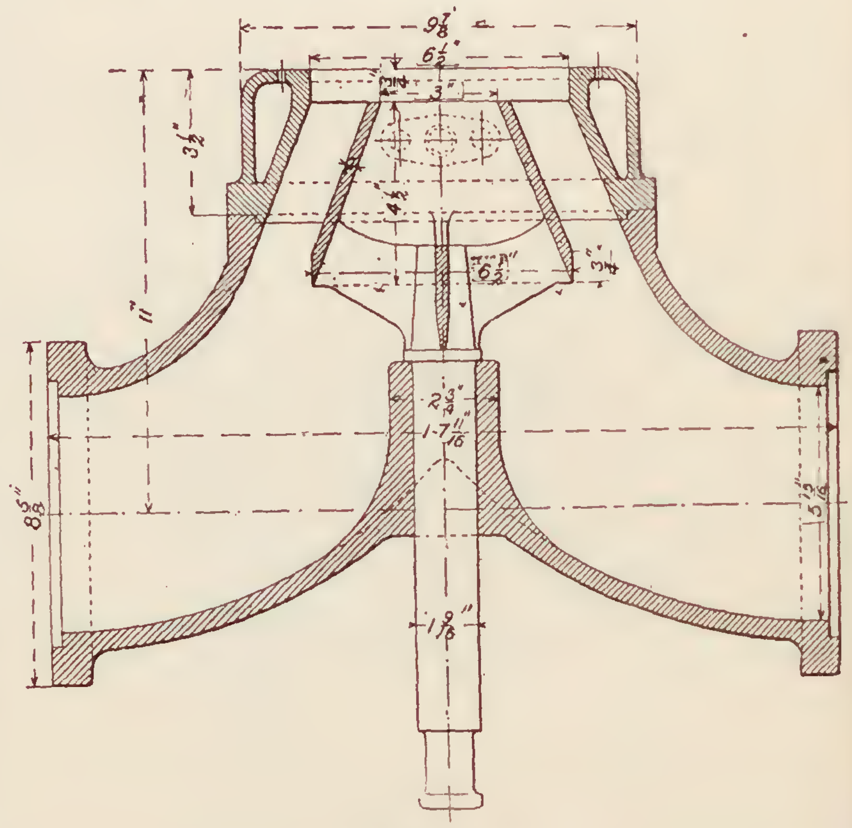


Fig. 11.

VARIABLE EXHAUST FOR LOCOMOTIVES ON THE ROUMANIAN RAILROADS.

where the tubes are covered with a light scale, and where the production was somewhat less than with new brass tubes, there was nothing to prove that the effect was due to the difference in the metals used.

Tests of the Influence of the Volume of the Smoke-box.—For a long time it has been generally admitted that the volume of the smoke-box should be somewhat restricted, but for the past 12 years the extended smoke-box has had the most general adoption in North America. The reason for this elongation seems to be to provide an extended netting area for arresting the sparks, and to afford a place for catching the cinders. The example for America was followed by a large number of European railway managers, who made trials of the extended smoke-box; but these attempts have not, as a rule, had any extended application. In America, even, the practice of this arrangement does not seem to be as generally admitted to be as useful as it was a few years ago.

Experiments on the effect of the volume of the smoke-box of delicate; for observations on the pressure in this space, traversed as it is by very rapid currents, is exceedingly difficult; and the pressure varies at very short intervals. Finally, the tests which were made seem to show that a great increase of the volume of the smoke-box does not improve the draft and offers no direct advantage.

Influence of Different Forms of Smoke boxes and Spark Arresters.—As a form of smoke-box that differs somewhat from the usual arrangements, we will cite the one adopted for the Belgian State locomotives; the stack, which is quadrangular and with a very large base, is like an extension of this box.

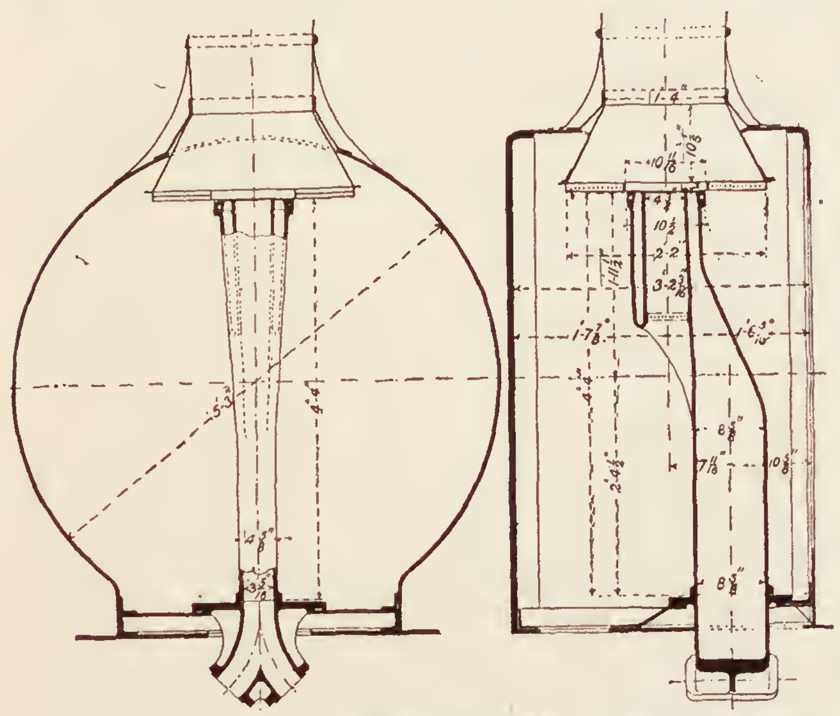


Fig. 12.

ANNULAR EXHAUST OF THE WESTERN RAILROAD OF FRANCE.

The working of these locomotives, provided as they are with very large grate-surfaces to burn exceedingly fine coal, is satisfactory; it is difficult, however, to express an opinion based on the value of the arrangements adopted for these locomotives in view of more general applications. The spark arresters are composed of a netting of iron wire with meshes more or less fine, and sometimes perforated plates. These accessories are compulsory in certain countries, especially in France, and are often used in other places.

When the nature of the fuel permits, it is perhaps advantageous to do away with them, for these screens always injure the draft. With the large meshes usually adopted they have no advantageous influence, especially in reducing to any great extent the amount of sparks thrown from the stack.

Instead of the flat screens, it is possible to use a netting in the form of a truncated cone, as shown in figs. 1 and 2. The Southern Railway Company of France use two grates, placed one above the other. Whatever may be the arrangement of these screens, it is hardly possible to avoid sparks when light fuel is used.

When fires are especially to be feared, it is then best to employ very powerful locomotives and avoid the use of certain light fuels. The use of the diamond stack as spark arresters, which was formerly in general use throughout the United States, is gradually disappearing. There are still, however, some applications of it to be found in Europe, as shown in figs. 3–6. Certain arrangements of this kind recall the chimney tops, which for several centuries have capped the chimneys of Venetian houses.

Tests of the Different Systems of Exhausts.—It is very difficult to get an exact valuation of different systems of exhausts by the aid of exact experiments, but the knowledge comes rather from observation of the working engines in regular service. With the ordinary blast pipe the variation of the section which can be easily obtained is a valuable assistant; the variable exhaust is in principle evidently superior to the fixed exhaust. It is, nevertheless, necessary to arrange it so that an exaggerated reduction of the opening cannot be made; the lack of suitable stops for limiting the closing of the valves is frequent, and doubtless the cause of the bad results obtained by this class of apparatus. The recent applications of the variable exhaust, which has been made in England, especially on the Great Eastern Railway, as shown in fig. 7, confirms this opinion. The practice of different companies, and especially the recent tests which have been made on the Eastern Railway of France, indicate that the position given in England to the top of the exhaust-pipe is the best one; it ought not to be much above the upper row of tubes. The conical prolongation of the stack down into the smoke-box, in the form of an inverted funnel, works very well with a slightly elevated exhaust. On the other hand, the exhaust-pipe in the bottom of the smoke-box with a series of sheet-iron cones superimposed over it has been generally abandoned, because it obstructs the smoke-box without any marked advantage. Fig 8 shows an example of a very low exhaust-pipe.

In America a deflector-plate which turns the gases and cinders down toward the bottom of the box is generally used with the extended front. Application of a similar arrangement has also been recently made in Europe. The Paris, Lyons & Mediterranean Railway Company have made an application of a special arrangement shown in fig. 9. The annular exhaust seems to utilize the steam and produce a good draft with a slight back pressure on the pistons, better than other systems. The pipe shown in fig. 10, designed by Mr. W. W. Adams, Engineer of the London & Southwestern Railway, has had an extensive application, and seems to have given general satisfaction. Figs. 11, 12, and 13 show different forms of the annular exhaust. Finally, a good arrangement of exhausts in the locomotives, which is really a matter of extreme importance, is best obtained by trials and by the applications of the empirical rules.

Tests of the Influence which Speed has on the Production of Steam.—The exhaust discharges become more frequent as the speed of the locomotive increases. At the same speed they are more rapid as the driving-wheels are smaller. As a whole, it does not appear that there is any special increase due to the multiplicity of the exhaust discharges. The most salient fact on this subject is the good combustion, which is usually obtained in the two-cylinder compound locomotives, as compared with the simple engines with the same number of cylinders.

The conclusions which have been reached as the results of these investigations are:

1. That, as a general rule, it is not best to have the tubes of locomotives longer than from 12 ft. 9 in. to 13 ft. $1\frac{1}{2}$ in.

2. The section for gas passage ought to be as large as possible, a point which justifies doing away with ferrules. The diameter of the tubes ought not to be too small, neither should they be too near together. As far as it is possible, it is best that their inside diameter should be from $1\frac{5}{8}$ to 2 in., and that

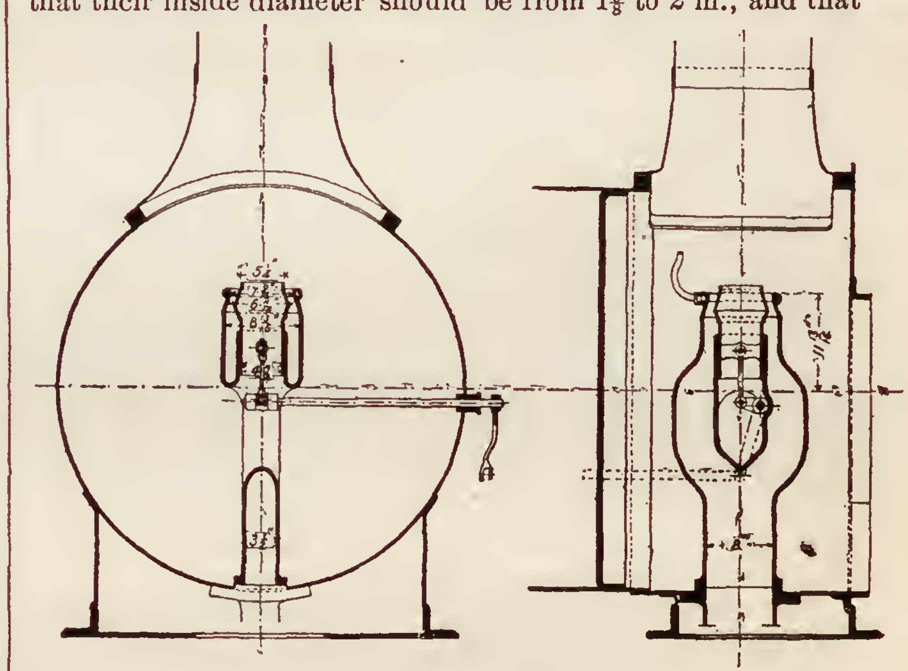


Fig. 13.

EXHAUST FOR LOCOMOTIVES ON THE GRAND CENTRAL RAILWAY OF BELGIUM.

the distance between the holes in the tube-sheets should not be less than from $\frac{5}{8}$ in. to $\frac{3}{4}$ in.

3. The Serve tubes work well on locomotives when their outside diameter is from $2\frac{3}{8}$ in. to $2\frac{3}{4}$ in., and when the length of the tube is short. It is, perhaps, advantageous to substitute them for ordinary tubes of 2 in. in diameter, but by making a corresponding reduction in the depth of the wings.

4. The comparative workings of the arrangements of the tubes, whether in staggered or vertical rows, does not appear, but preference is generally given to the second arrangement.

5. The kind of metal used is a matter of indifference from the standpoint of the production of steam.

6. The effect of volume of the smoke arch is hardly perceptible. The extended smoke-box of the American type, as tested in Europe by many railroads, does not seem, as a gen-

eral rule, to give any better results than boxes of average capacity. It seems preferable, therefore, to retain the latter.

7. No marked superiority can be claimed for any particular type of stack. That form which is slightly conical and belled out toward the top seems preferable in a general way. It is well to extend the stack down into the interior of the smoke-box, belling it out larger into the form of a funnel. The height of the exhaust pipe should not be above the upper row of tubes.

8. No arrangement of spark arresters can be set down as possessing a marked advantage. All hinder the draft to a greater or less extent without being absolutely efficient. The simple netting suffices in almost every case.

9. Among the different systems of exhaust, the annular arrangement seems to be slightly superior to the others. It is complicated when it is desired to render the section of the pipe variable; in other respects it is desirable.

10. All single exhaust-pipes should be variable. It is best, however, that the variation should not have so wide a range as to permit too great a reduction of section. It is doubtless due to the lack of such a limit that variable exhausts have been so often considered injurious or useless. The simple arrangement of two movable valves seems very efficient.

11. We will repeat here the recommendation laid down in No. 7 above, regarding the exhaust-pipe, which ought not to be above the upper row of tubes, even if the stack is not extended down into the smoke-box.

12. The speed has no influence on the production of the steam; in other words, with an equal weight of steam exhausted per minute with the same pressure in the cylinders at the beginning of the pre-exhaust, the greater or less frequency of the exhaust impulse is a matter of indifference. This fact has been brought out by the working of two-cylinder compound locomotives.

INSTRUCTIONS TO BOILER ATTENDANTS.

The Manchester Steam Users' Association a few months ago issued a revised and enlarged edition of its "Instructions to Boiler Attendants." These we have pleasure in reproducing, believing that their publication may prove useful to steam users.

Getting up Steam.—Warm the boiler gradually. Do not get up steam from cold water in less than six hours. If possible, light the fires over night.

Nothing turns a new boiler into an old one sooner than getting up steam too quickly. It hogs the furnace tubes, leads to grooving, strains the end plates, and sometimes rips the ring seams of rivets at the bottom of the shell. It is a good plan to blow steam into the cold water at the bottom of the boiler, or to open the blow-out tap and draw the hot water down from the top.

Firing.—Fire regularly. After firing, open the ventilating grid in the door for a minute or so. Keep the bars covered right up to the bridge. Keep as thick a fire as the quality of coal will allow. Do not rouse the fires with a rake. Should the coal cake together, run a slicer in on the top of the bars and gently break up the burning mass.

Repeated trials have shown that under ordinarily fair conditions no smoke need be made with careful hand-firing. Alternate side-firing is very simple and very efficacious.

Cleaning Fires and Slaking Ashes.—Clean the fires as often as the clinker renders it necessary. Clean one side at a time, so as not to make smoke. Do not slake the clinkers and ashes on the flooring plates in front of the boiler, but draw them directly into an iron barrow and wheel them away.

Slaking ashes on the flooring plates corrodes the front of the boiler at the flat end-plate, and also at the bottom of the shell where resting on the front cross wall.

Feed-Water Supply.—Set the feed-valve so as to give a constant supply, and keep the water up to the height indicated by the water-level pointer.

There is no economy in keeping a great depth of water over the furnace crowns, while the steam space is reduced thereby, and thus the boiler rendered more liable to prime. Nor is there any economy in keeping a very little water over the furnace crowns, while the furnaces are thereby rendered more liable to be laid bare.

Glass Water Gauges and Floats.—Blow through the test tap at the bottom of the gauge hourly, as well as through the tap in the bottom neck, and the tap in the top neck twice daily. These taps should be blown through more frequently when the water is sedimentary, and whenever the movement of the water in the glass is at all sluggish. Should either of the thoroughfares become choked, clean them out with a wire. Work the floats up and down by hand three or four times a day to see that they are quite free. Always test the glass water gauges and the floats thoroughly the first thing in the morning before firing up, and at the commencement of every shift.

It does not follow that there is plenty of water in the boiler because there is plenty of water in the gauge glass. The passages may be choked. Also EMPTY gauge glasses are sometimes mistaken for FULL ones, and explosions have resulted therefrom. Hence the importance of blowing through the test taps frequently.

Blow-out Taps and Scum Taps.—Open the blow-out tap in the morning before the engine is started, and at dinner time when the engine is at rest. Open the scum tap when the engine is running, before breakfast, before dinner, and after dinner. If the water is sedimentary, run down ½ in. of water at each blowing. If not sedimentary, merely turn the taps round. See that the water is at the height indicated by the water-level pointer at the time of opening the scum tap. Do not neglect blowing out for a single day, even though anti-incrustation compositions are put into the boiler.

Water should be blown from the bottom of the boiler when steam is NOT being drawn off, so that the water may be at rest and the sediment have an opportunity of settling. Water should be blown from the surface when steam is being drawn off, so that the water may be in ebullition and the scum floating on the top. If the water be below the pointer, the scum tap will blow steam; if above the pointer, the scummer will miss the scum.

Safety-Valves.—Lift each safety-valve by hand in the morning before setting to work, to see that it is free. If there is a low-water safety-valve, test it occasionally by lowering the water level to see that the valve begins to blow at the right point. When the boiler is laid off, examine the float and levers and see that they are free, and that they give the valve the full rise.

If the safety-valves are allowed to go to sleep, they may get set fast.

Opening Drain-Taps and Steam-Pipes.—If the boiler is one of a range and the branch steam-pipe between the junction valve and the main steam-pipe is so constructed as to allow water to lodge therein, open the drain tap immediately the boiler is laid off, and keep it open until the boiler is set to work again. If the main steam-pipe is so constructed as to allow water to lodge therein, open the drain-tap immediately the engine is shut down, and keep it open till the engine is set to work again.

If water is allowed to lodge in the pipes, it is impossible to blow it out under steam pressure without danger. Attempting to do this frequently sets up a water hammer action within the pipes, and from this cause several explosions have occurred. The only safe plan is NOT to let lodgment occur, or to shut off the steam before opening the drain-taps.

Shortness of Water.—If the boiler is found to be short of water, throw open the fire-doors, lower the dampers, ease the safety-valves, and set the engine going, if at rest, so as to reduce the pressure. If the boiler is one of a series shut down the junction valve. If there is reason to conclude that the water has not sunk below the level of the furnace crowns, and they show no signs of distress, turn on the feed, and either draw the fires quickly, beginning at the front, or smother them with ashes or anything ready to hand. If there is reason to conclude that the water has sunk below the level of the furnace crowns, withdraw, and leave the safety-valves blowing. Warn passers-by from the front.

EASING THE SAFETY-VALVES.—If either the construction of the boiler or the character of the feed-water is such as to render the boiler liable to prime, the safety-valve should be eased gently.

TURNING ON THE FEED.—From experiments the M. S. U. A. has conducted, it appears that this is the best thing to do in nearly every case, especially where the feed is introduced behind the firebridge, as it would tend to restore the water level, and at the same time to cool and reinvigorate the furnace plates. While, however, the experiments showed that showering cold water on to red-hot furnace crowns would not, as had been generally supposed, lead to a sudden and violent generation of steam which the safety-valves could not control, and the shell could not resist, it is thought that if the furnace crowns were very hot and just on the point of giving way, the generation of a few additional pounds of steam might turn the scale and lead to collapse. Thus it might be wise to turn on the feed in some cases and not in others, according to the extent to which the furnaces were overheated, and this it is difficult to ascertain. Under these circumstances a hard and fast rule applicable to all cases cannot be laid down, and therefore having regard to the safety of the fireman, the advice to turn on the feed, as a general rule, is confined to those cases where the water has not sunk below the level of the furnace crowns.

DRAWING THE FIRES.—This ought not to be attempted if the furnace crowns have begun to bulge out of shape. At Clay Cross, near Chesterfield, on Thursday, January 14, 1869, as the attendant was in the act of drawing the fire from a Cornish boiler overheated from shortness of water, the furnace crown rent, when the torrent of steam and hot water that ensued blew him backward to a distance of 25 yards, rake in hand, and killed him on the spot. At Gorton, near Manchester, on Tuesday, September 15, 1885, the attendant on discovering that the water had disappeared from the gauge glass, immediately began to draw the fires. While engaged in doing this the crown of the left-hand furnace collapsed, and the attendant was so seriously scalded that he died the same day. Drawing the fires when the water is out of sight must always be a matter of more or less risk, as there is a difficulty in determining how far and for how long a time the furnace crowns have been laid bare. If it is known that the water has only just passed out of sight, say from the sticking fast of the blow-out tap when attempting to shut it, the fires might be drawn with safety. But if an empty gauge glass has been mistaken for a full one, and the boiler has been worked on in this state for some time, the case will be different. Again, there would be more risk in drawing the fires from a plain furnace tube than from one strengthened with encircling rings, and from one made of ordinary plates than from one made of ductile steel, or of iron equal to Low Moor or Bowling. So that a fire may be safely drawn in one case and not in another. DISCRETION MUST BE EXERCISED.

It is an extremely responsible task to give any recommendation with regard to the treatment of a boiler when short of water and working under steam pressure, that shall be applicable to every case under every variety of circumstance. A boiler attendant has no right to neglect his water supply and allow it to run short, nor has he a right to charge the fires without making sure that the furnace crowns are covered. Should he neglect these simple precautions it is impossible to put matters right without some risk being run. A boiler with hot fires and with furnace crowns short of water is a dangerous instrument to deal with, and the attendant who has done the wrong must bear the risk. The best advice the M. S. U. A. can give the boiler attendants on this subject is, Do not let Shortness of Water Occur. Keep a Sharp Look-out on the Water-Gauge.

Use of Anti-Incrustation Compositions.—Do not use any of these without the consent of the M. S. U. A. If used, never introduce them in heavy charges at the manhole or safety-valve, but in small daily quantities along with the feed-water.

Many furnace crowns have been overheated and bulged out of shape through the use of anti-incrustation compositions, and in some cases explosions have resulted. See M. S. U. A. Monthly Reports for June, 1869, and April, 1877.

Emptying the Boiler.—Do not empty the boiler under steam pressure, but eool it down with the water in ; then open the blow-out tap and let the water pour out. To quieken the cooling the damper may be left open, and the steam blown off through the safety-valves. Do not on any account dash eold water on to the hot plates. But in eases of emergency, pour eold water in before the hot water is let out, and mix the two together, so as to cool the boiler down generally, and not loeally.

If a boiler is blown off under steam pressure the plates and brickwork are left hot. The hot plates harden the scale, and the hot brickwork hurts the boiler. Cold water dashed on to hot plates will cause severe straining by local contraction, sometimes sufficient to fracture the seams.

Cleaning Out the Boiler.—Clean out the boiler at least every two months, and oftener if the water is sedimentary. Remove all the scale and sediment as well as the flue dust and soot. Show the scale and sediment to the manager. Pass through the flues, and see not only that all the soot and flue dust has been removed, but that the plates have been well brushed. Also see whether the flues are damp or dry, and if damp find out the cause. Further, see that the thoroughfares in the glass water-gauges and in the blow-out elbow-pipe, as well as the thoroughfares and the perforations in the internal feed dispersion-pipe and the scum-pipe are free. Take the feed-pipe and the scum troughs out of the boiler if necessary to elean them thoroughly. Take the taps, if not asbestos-packed, and the feed-valve to pieces, examine, elean, and grease them, and if necessary grind them in with a little fine sand. Examine the fusible plugs.

All taps, whether asbestos-packed or metal to metal, should be followed in working, especially when new. The gland should be screwed down as found necessary so as to keep the plug down to its work, otherwise it may rise, let the water pass, and become scored.

Preparation for Entire Examination.—Cool the boiler and carefully clean it out as explained above, and also dry it well internally. When the inspeetor eomes, show him both scale and sediment as well as the old cap of the fusible plug, and tell him of any defects that have manifested themselves in working, and of any repairs or alterations that have been made since the last examination.

Unless a boiler is suitably prepared, a satisfactory entire examination cannot be made. Inspectors are sent at considerable expense to make entire examinations, and it is a great disappointment when their visits are wasted for want of preparation.

Precautions as to Entering Boiler.—Before getting inside the boiler, if it is one of a series, take off the junetion-valve hand-wheel, and if the blow-out tap is connected to a common waste-pipe, make sure that the tap is shut and the key in safe keeping.

From the neglect of these precautions, men working inside boilers have been fatally scalded.

Fusible Plugs.—Keep these free from soot on the fire side and from incrustation on the water side. Change the fusible metal once every year, at the time of preparing for the M. S. U. A. annual entire examination.

If fusible plugs are allowed to become incrusted, or if the metal be worked too long, they become useless, and many furnace crowns have rent from shortness of water, even though fitted with fusible plugs.

General Keeping of Boiler.—Polish up the brass and other bright work in the fittings. Sweep up the flooring plate frequently. Keep ashes and water out of the hearth pit below the flooring plates. Keep the space on the top of the boiler free, and brush it down once or twice a week. Take a pleasure in keeping the boiler and the boiler-house clean and bright, and in preventing smoke.

Lavington E. Fletcher, *Mem. Inst. C.E.*,
Chief Engineer.

Offices of the Manchester Steam Users' Association, 9 Mount Street, Albert Square, Manchester, September 14, 1893.

TO BOILER-OWNERS.

A drain tap should be fixed in every branch steam-pipe, as well as in every main steam-pipe which is so laid as to allow water to accumulate therein.

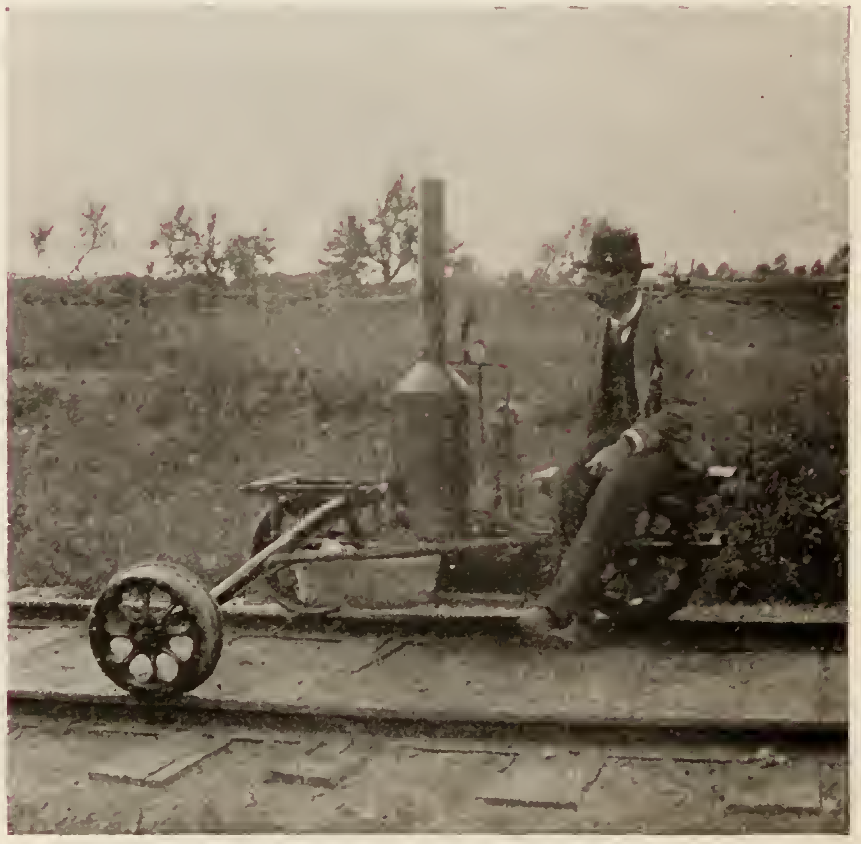
A water-gauge tap fixed to the front of the boiler on a level with the top of the furnace crowns would help a boiler attendant, in case of shortness of water, to determine whether it was safe to draw the fires and turn on the feed.

A low-water safety-valve would give warning in the event of shortness of water in time to prevent danger.

The feed should be delivered well behind the fire-bridge.

A STEAM INSPECTION CAR.

The steam inspection car, of which we give an illustration, is one that has been designed and built by Mr. E. S. Barnes, of Rochester, Mich., and is used by him in going and returning from work at the crossing of the Michigan Central & M. A. L. Railroad. The car is of the three-wheeled type that is so well known and that has been used for so many years. The engine is a single, vertical engine with a cylinder $2\frac{3}{16}$ in. in diameter, with a piston-stroke of 3 in. The driving-wheels are 17 in. in diameter, and are geared to the engine by means of a No. 25 sprocket wheel and chain. The sprocket wheel on the engine shaft has 13 teeth, while that on the driving-axle has 22 teeth, so that the engines make $1\frac{9}{13}$ revolutions for each revolution of the wheel. This proportion is such that the engine makes about 2,000 revolutions per mile.



BARNES' STEAM INSPECTION CAR.

The boiler is of the porcupine type, and is built with a central pipe 3 in. in diameter and 20 in. long with seventy-four $\frac{3}{4}$ in. nipples, each $3\frac{1}{2}$ in. long, screwed into the main pipe. These nipples have caps over the ends. The boiler is an exeeedingly good steamer. The water tank is 5 in. × 7 in. × 20 in., and will hold enough water to make a run of from 8 to 9 miles with one person, but when an extra man is carried the distanee is redueed to about 5 miles. The piston of the boiler feed-pump is $\frac{5}{8}$ in. in diameter, and has a stroke of 2 in.; it is connected direetly to the engine by means of a face-plate, and so arranged that by turning a thumb-screw the piston will be released from the pitman and the pump can be worked by hand. There is a valve placed in the pipe so that the flow of the water to the boiler can be regulated in such a way that it will require but very little attention, and the car has been run for 6 miles without touehing the feed-valve.

The jacket of the boiler is 11 in. in diameter and 26 in. high to the slope of the hood, and the stack is 4 in. in diameter and 28 in. high. The engine exhausts directly into the stack in order to increase the draft, but the exhaust-pipe is so

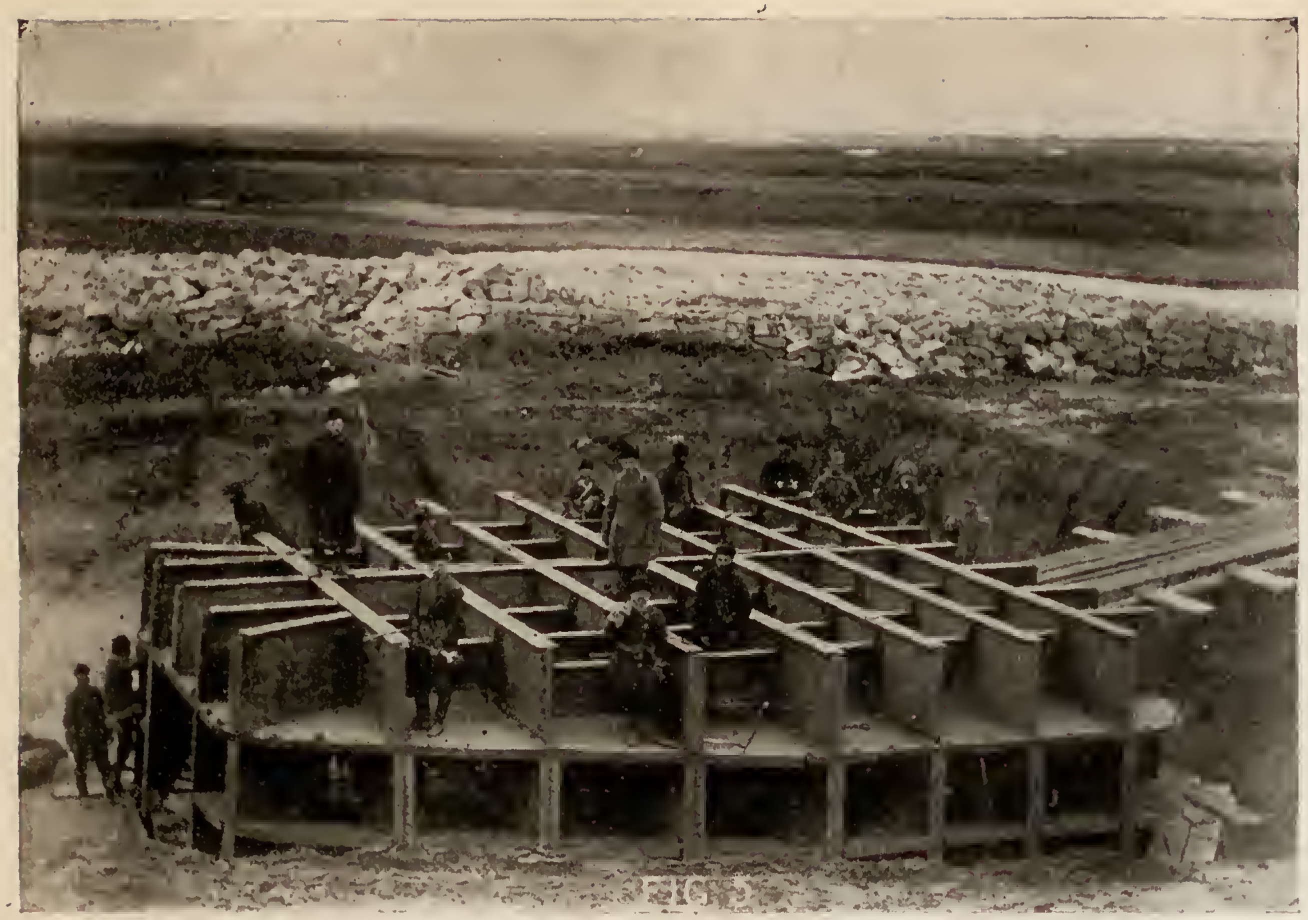


FIG. 5

FIG. 6

FIG. 7

FIG. 8.

SCENES ON THE GREAT SIBERIAN RAILROAD DURING CONSTRUCTION.

arranged that it can be cut off from the stack and the escaping steam delivered beneath the car.

The framing is in imitation of that of the three-wheeled Sheffield velocipede car. The main frame is 12 in. wide between the side rails to accommodate the boiler, which is dropped down between them to within 2 in. of the track, thus bringing the weight down quite low and giving a good balance. The fastest run that has thus far been made with the car is 4 miles in $11\frac{1}{2}$ minutes, which is a trifle more than 20 miles per hour. This was without any wind, but it can be depended upon to make 15 miles an hour on an average. Coal is used for fuel, and runs of 4 miles have been repeatedly made without firing.

VIEWS ON THE WESTERN SIBERIAN RAILROAD.

Herewith we give another page of engravings of the interesting photographs which have been received from a correspondent engaged on this important work. Figs. 5 and 6 represent the riveting of the caisson of bridges over the Tobol River, fig. 7 represents a timber bridge over the Outiak River, and fig. 8 represents a working train unloading.

We expect to supplement these views with others which will indicate the energy and rapidity with which this great transcontinental line is being pushed across the Continent of Asia, and which is daily becoming of greater international importance.

SUPERINTENDENT'S ENGINE, LEHIGH VALLEY RAILROAD.

On every large road it is important that an engine should stand ready, like the horses in a fire-engine house, to start at a moment's notice to carry the officers of the road to that point requiring their immediate presence. The engine which we illustrate by reproductions of a drawing and a photograph (the latter having been kindly loaned by the *Locomotive Engineering*) show one that is in service on the Lehigh Valley Railroad. It is in reality a Forney type of locomotive, housed over and provided with comfortable seats in the cab over the boiler, to which access is gained by steps and doors at the front end. The engravings show all of the details so clearly that the following list of dimensions will afford a clear idea of the mechanical construction :

Kind of fuel used (anthracite or bituminous coal, or wood)	Anthracite.

WEIGHT AND GENERAL DIMENSIONS.

Gauge of road	4 ft. $8\frac{1}{2}$ in.
Total weight of locomotive in working order, including two men	71,680 lbs.
Total weight on driving-wheels	25,500 lbs.
" wheel base	25 ft. $5\frac{1}{2}$ in.
Distance from center of main driving-wheels to center of cylinders	9 ft. 9 in.
Length of main connecting-rod from center to center of journals	6 ft. $4\frac{3}{8}$ in.
Transverse distance from the center of one cylinder to the center of the other	6 ft. 2 in.
Diameter of cylinder and stroke of piston	11 in. × 20 in.
Kind of piston packing	Steam.
Diameter of piston rod	$1\frac{7}{8}$ in.
Size of steam port	9 in. × 1 in.
" " exhaust port	9 in. × $1\frac{3}{4}$ in.
Greatest travel of slide valve	5 in.
Inside lap of slide valve	$\frac{1}{4}$ in.
Outside lap of slide valve	$\frac{3}{4}$ in.
Lead of slide valves in full stroke	$\frac{1}{32}$ in.
Throw of upper end of reverse lever from full gear forward to full gear backward, measured on the chord of the arc of its throw	$34\frac{1}{2}$ in.

WHEELS, ETC.

Diameter of driving-wheels outside of tires	4 ft. 6 in.
" " front truck wheels	2 ft.
" " back truck wheels	2 ft.
Size of main driving-axle journal, diameter and length	6 in. × 8 in.
" " truck axle journals, diameter and length	$4\frac{1}{2}$ in. × 7 in.
" " main crank-pin journals, diameter and length	3 in. × 3 in.
Length of driving springs measured from center to center of hangers	36 in.

BOILER.

Description of boiler	Wagon top.
Inside diameter of smallest boiler ring	36 in.
Material of barrel of boiler	Steel.
Thickness of plates in barrel of boiler	$\frac{7}{16}$ in.
Kind of horizontal seams	Single.
" " circumferential seams	Single.
Material of tubes	Iron.
Number " "	119
Diameter of tubes, outside	$1\frac{3}{4}$ in.
Distance between center of tubes	$2\frac{1}{2}$ in.
Length of tubes over tube plates	9 ft. $3\frac{1}{2}$ in.
Length of fire-box	60 in.
Width " "	42 in.
Depth " "	33 in.
Water space, side of fire-box	$2\frac{1}{2}$ in.
" " back " "	$3\frac{1}{2}$ in.
" " front " "	$3\frac{1}{2}$ in.
Material of outside shell of fire-box	Steel.
Thickness of plates of outside shell of fire-box	$\frac{5}{16}$ in.
Material of inside fire-box	Steel.
Thickness of plates inside	$\frac{5}{16}$ in.
" " " back end of fire-box	$\frac{5}{16}$ in.
" " row plate	[illegible] in.
Material of tube plates	Iron.
Thickness of front tube plates	$\frac{1}{2}$ in.
" " back " "	$\frac{1}{2}$ in.
How crown plate is stayed	Crown bars.
Diameter of dome	24 in.
Height " "	26 in.
Maximum working pressure per sq. in	130 lbs.
Kind of grate	Water bars.
Width of bars (or diameter of tubes of water grates)	$1\frac{7}{8}$ in.
" " opening between bars (or tubes)	1 in.
Grate surface	17.5 sq. ft.
Heating surface in fire-box	27 sq. ft.
" " of the inside of tubes	446 sq. ft.
Total heating surface	473 sq. ft.
Kind of blast nozzle, single or double	Double.
Diameter of blast nozzle	Each 4.090 in. = to $2\frac{9}{32}$ in. diam. round.
Smallest inside diameter of chimney	12 in.
Height from top of rails to top of chimney	14 ft. 3 in.
" " " " " " center of boiler	5 ft. $1\frac{3}{4}$ in.

TENDER OR TANK.

Distance from center to center of truck wheels of tender	3 ft. 10 in.
Water capacity of tank (in gallons of 231 cu. in.)	1,165 galls.
Coal capacity of tender or fuel bin	2 tons.

ENGINE AND TENDER.

Total length of engine and tender over all	35 ft. $\frac{1}{2}$ in.

FIRST ANNUAL REPORT OF THE DIRECTORS TO THE STOCKHOLDERS OF THE BALTIMORE & OHIO RAILROAD COMPANY.

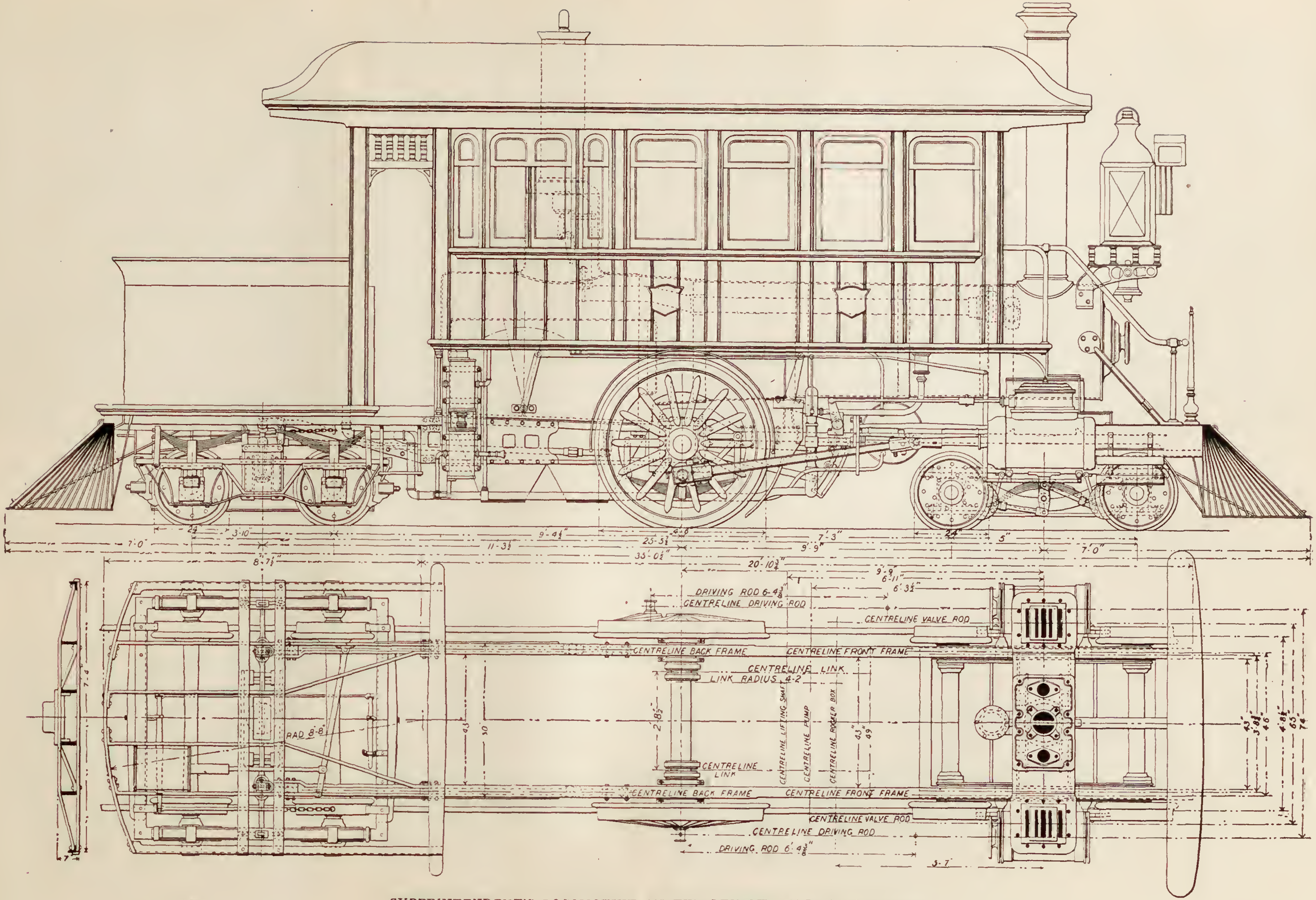
The directors of the Baltimore & Ohio Railroad Company, in conformity with the provisions of their charter, submit to the first general meeting of the stockholders a statement of the affairs of the company and of the measures they are pursuing in order to carry into effect the important object for which this corporation has been instituted.

In accepting the trust with which they have been invested the board were aware of the deep responsibility that would devolve upon them. They were fully apprised of the high expectations which their constituents had formed of the results of this undertaking, and well acquainted with the general impression that nothing would be required to ensure its success but a judicious application of the means at the disposal of the company. They could not, therefore, be insensible that they owed it to the public, to their constituents and to themselves, in the management of a work involving such varied and extensive operations, and from which such important advantages were anticipated, to proceed with caution and not endanger the object by a premature commencement.

They have, accordingly, been actively engaged in collecting the necessary information, in order that they might secure a judicious location of the road, and be enabled to decide upon the most efficient and least expensive moving power to be employed upon it. Much valuable knowledge upon these points has already been gained ; and the board are constantly collecting additional facts which afford important illustrations of the subject, and greatly strengthen their confidence of success. They now believe that, however this course of procedure may have retarded the commencement, it will ensure a more early, more economical and more certain completion of the work.

The directors have also deemed it of primary importance, in the first instance, to secure the services of an engineer upon whose talents and skill they might safely rely. It is their desire, not less than their duty, to obtain the best professional aid the country will afford, and they will spare no efforts to engage a superintendent of the highest character.

The Government of the United States, justly appreciating the importance of this enterprise, have extended to it a most liberal patronage. Several able and efficient members of the Topographical Corps have been detached to the services of the company. These officers have examined various routes from the city of Baltimore to the valley of the Potomac, and along



SUPERINTENDENT'S LOCOMOTIVE ON THE LEHIGH VALLEY RAILROAD.

that ravine as far as Cumberland. They are now engaged in a general reconnoissance of the country between the Potomac and Ohio rivers, and are expected to return in a few weeks prepared to lay before the board the result of their labors. Should a chief engineer by that time have been engaged, the board entertain the hope that they will soon after be ready to commence the actual location and construction of the road.

The directors take great pleasure in acknowledging the general approbation and good will with which this enterprise is regarded throughout our country, and particularly in those sections of the West more immediately interested in its success. They have received communications from almost every district between this city and Ohio, as well as from many parts of that flourishing State, giving assurances of a cordial desire to afford the company every aid and support, and of a general willingness on the part of the landholders to relinquish the ground necessary for the road free of cost.

SUPERINTENDENT'S LOCOMOTIVE ON THE LEHIGH VALLEY RAILROAD.

In conclusion, the board feel a high satisfaction in stating, as the result of all the information and experience they have yet acquired, that their confidence in the practicability of the railroad remains unabated, and that they believe the most sanguine calculations of its importance and utility, whether the object be regarded with reference to its national and local advantages or its profits to the stockholders, will be realized.

By order of the board,

P. E. Thomas, *President*.

Baltimore, October 1, 1827.

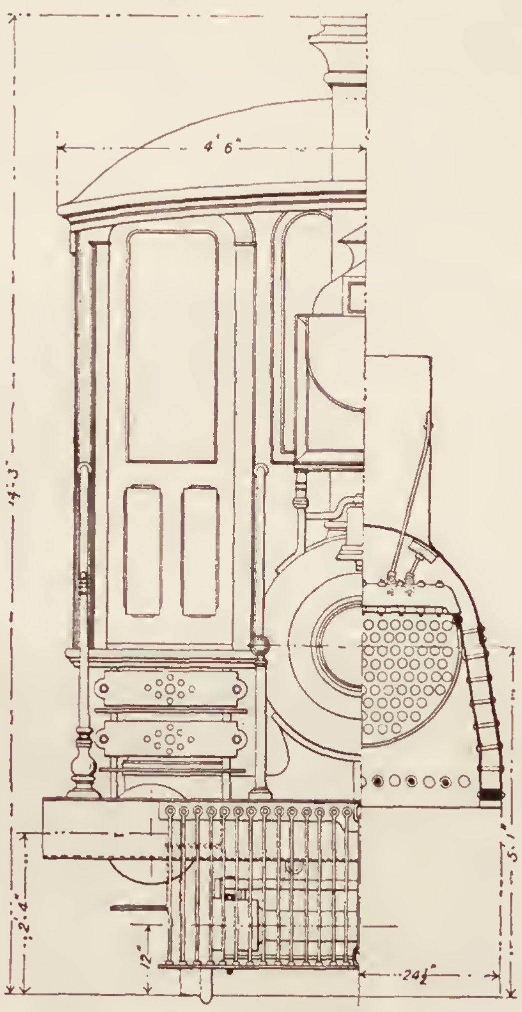
COMPOUND LOCOMOTIVE ON THE PARIS, LYONS & MEDITERRANEAN RAILWAY.

Through the courtesy of M. Beaudry, Chief of Material and Traction of the Paris, Lyons & Mediterranean Railway, we are enabled to present engravings of an outline, and photograph of a new locomotive which has recently been constructed for that railway, with a view of determining the amount of end resistance which a locomotive experiences due to the air pressures generated by the speed at which it is moving. It will be noticed that the front surfaces coming in contact with the atmosphere are given a sharp face for purposes of enabling them to cut through the air with the least possible resistance. The locomotive in other respects is similar to one that was exhibited by this company at the Antwerp Exposition last summer. It is a four-cylinder compound locomotive, having two high and two low-pressure cylinders. The four cylinders are arranged two inside and two outside of the frame; the pistons of the two on the inside are connected with the front driving-wheels, and the two on the outside are connected with the rear driving-wheels. The boiler pressure is 213 lbs. to the square inch. The steam passes directly from the boiler to the outside cylinders, and from there to the inside cylinders, where its final expansion is accomplished.

The valve-motion on the high-pressure cylinders is on the Walschaert system; that of the low-pressure cylinders is designed on a special system without an eccentric, and which has already been used on a locomotive exhibited by the Paris, Lyons & Mediterranean Railway Company at Paris, in 1889. The four valves are controlled by a single reversing gear, which establishes for each notch a ratio independent of the control of the engineer, and which has been worked out in the details by the designers.

There is also a special cock, by means of which the engineer can admit steam directly from the boiler into the intermediate receiver that is between the large and small cylinders; but this is for starting only, and without allowing the steam from the small cylinder to escape into the air. A spring safety-valve, placed on the receiver, and opening into the atmosphere, prevents the pressure therein from rising above 85 lbs. to the square inch.

Although each of the two driving-axles are connected direct to an independent pair of cylinders, they are nevertheless coupled together in such a way as to maintain their relative angularity fixed, and to thus increase as much as possible the moment of starting. The engine resembles the eight-wheeled American type, in which the back end is carried by the driving-wheels, while the front is carried by a four-wheeled bogie truck, whose centre plate is spherical. The angular displacements of the bogie relatively to the locomotive is controlled by helicoidal surfaces, on which the locomotive rises, and thus tends to bring the bogie back into its central position. This latter has, however, a side play of ⅝-in. on each side of its normal position, with surfaces inclined at an angle of 15 per cent. The boiler of the Antwerp engine, including the fire-box, is of mild steel, but the engine illustrated has a copper fire-box. The tubes are also of steel, and are of the Serve pattern. The use of Serve tubes gives a larger heating surface, and allows the use of tubes of moderate length, while the use of steel for the fire-box has permitted a considerable reduction to be made in the weight of the locomotive in spite of the four cylinders and the four mechanisms connected therewith, but this, of course, does not apply to this engine.



HALF FRONT ELEVATION. [SECTION AT FIRE-BOX.

SUPERINTENDENT'S LOCOMOTIVE, LEHIGH VALLEY RAILROAD.

We naturally await with a great deal of interest the results of the experiments which will be made to determine the saving in coal consumption, if there is any, with this novel form of front end for a locomotive. There is no doubt that the exhaustive manner of testing which is in vogue on the great French railways, when the solution of any question is once undertaken, will contribute a great deal of the important information not only in regard to the head resistances of trains, but also in regard to wind pressures in general.

The following is a *résumé* of the general dimensions of this locomotive:

Grate.

Length	7 ft. 3½ in.
Breadth	3 ft. 4$\frac{5}{16}$ in.
Area G	24.5 sq. ft.
Inclination of bars	20 deg. 4 in.

Fire-box.

Height of crown-sheet above bottom of the mud-ring, front.	5 ft. 11⅜ in.
" " " " " " " " " " back.	3 ft. 8$\frac{11}{16}$ in.
Length of the inside, top	6 ft. 11⅞ in.
" " " " bottom	7 ft. 3½ in.
Inside breadth, top	3 ft. 6¾ in.
" " bottom	3 ft. 10$\frac{5}{16}$ in.
Thickness of copper side and back sheet	$\frac{9}{16}$ in.
" " tube sheets at the tubes	1 in.
" " " " below tubes	$\frac{9}{16}$ in.

Tubes (Serve).

Number of tubes	133
Material of tubes	Steel.
Outside diameter	2$\frac{9}{16}$ in.
Thickness at wings	$\frac{1}{16}$ in.
Length between tube sheets	9 ft. 10⅛ in.
Number of wings in each tube	8
Height of wings	½ in.
Average of thickness of wings	$\frac{1}{16}$ in.

Heating Surfaces.

Fire-box above the mud-ring, F	102½ sq. ft.
Tubes inside measurement, T	1,474¾ sq. ft.
Total, S	1,577¼ sq. ft.
Ratio of heating surface of tubes to fire-box $\frac{T}{F}$	13.18 to 1
Ratio of total heating surface to grate area $\frac{S}{G}$	63.70 to 1

Boiler.

Outside length of fire-box	7 ft. 10½ in.
" breadth " " top	4 ft. 5¾ in.
" " " " bottom	3 ft. 11¼ in.
Inside diameter of largest ring of shell	4 ft. 4 in.
Length of shell	9 ft. 5¾ in.
Thickness of sheets in shell	$\frac{9}{16}$ in.
Inside length of smoke-box	5 ft. 1⅜ in.
" diameter of smoke box	4 ft. 5⅝ in.
Centre of boiler above top of rail	7 ft. 4⅝ in.
Bottom mud-ring at the front above rail	2 ft. 2¾ in.
Volume of water in boiler with 4 in. above crown-sheet	99⅝ cu. ft.
Total capacity of boiler	180¾ cu. ft.
Steam space	81⅛ cu. ft.
" pressure	213 lbs. per sq. in
Diameter of safety valves	3$\frac{9}{16}$ in.

Smoke Stack.

Inside diameter of stack	1 ft. 9¼ in.
Height of stack above rail	13 ft. 11¾ in.

Air Passages.

Through grate	12⅝ sq. ft.
" tubes at the fire-box ferrules	3⅛ sq. ft.
" " " " centre	4 sq. ft.
Ratio of stack to tubes	1 to 1.52
Clear inside section of stack	1$\frac{13}{16}$ sq. ft.

Frames.

Distance between frames on inside	4 ft. $\frac{13}{16}$ in.
Thickness of side bars	1 in.
Length of engine over buffers	32 ft. 2⅝ in.
Wheel base, forward truck	6 ft. 6¾ in.
Distance from back truck front driving wheels	7 ft. 2⅝ in.
Driving-wheel base	8 ft. 10¼ in.
Total wheel base	22 ft. 7⅝ in.

Wheels.

Diameter of truck wheels	3 ft. 3⅜ in.
" " driving wheels	6 ft. 6¾ in.
Lateral play of truck centre plate	⅝ in.
" " " " axles	⅜ in.
" " " driving axles	⅜ in.
Distance between inside tires	4 ft. 5½ in.
Diameter of centre truck wheels	1 ft. 11⅞ in.
" " " driving-wheels	6 ft. 1¼ in.
Centre to centre of truck journals	3 ft. 7 in.
" " " " driving journals	3 ft. 9¼ in.
Diameter of truck journals	5⅞ in.
Length of truck journals	10⅝ in.
Diameter of driving axles	7⅞ in.
Length of driving axles	9⅞ in.
Crank-pins, high pressure, diameter.	4$\frac{5}{16}$ in.
" " " " length	4¾ in.
" " low " diameter	8½ in.
" " " " length	4$\frac{5}{16}$ in.
" " side rods, large ends, diameter	5⅛ in.
" " " " " " length	3⅛ in.
" " " " small ends, diameter	3⅛ in.
" " " " " " length	3⅛ in.

Springs.

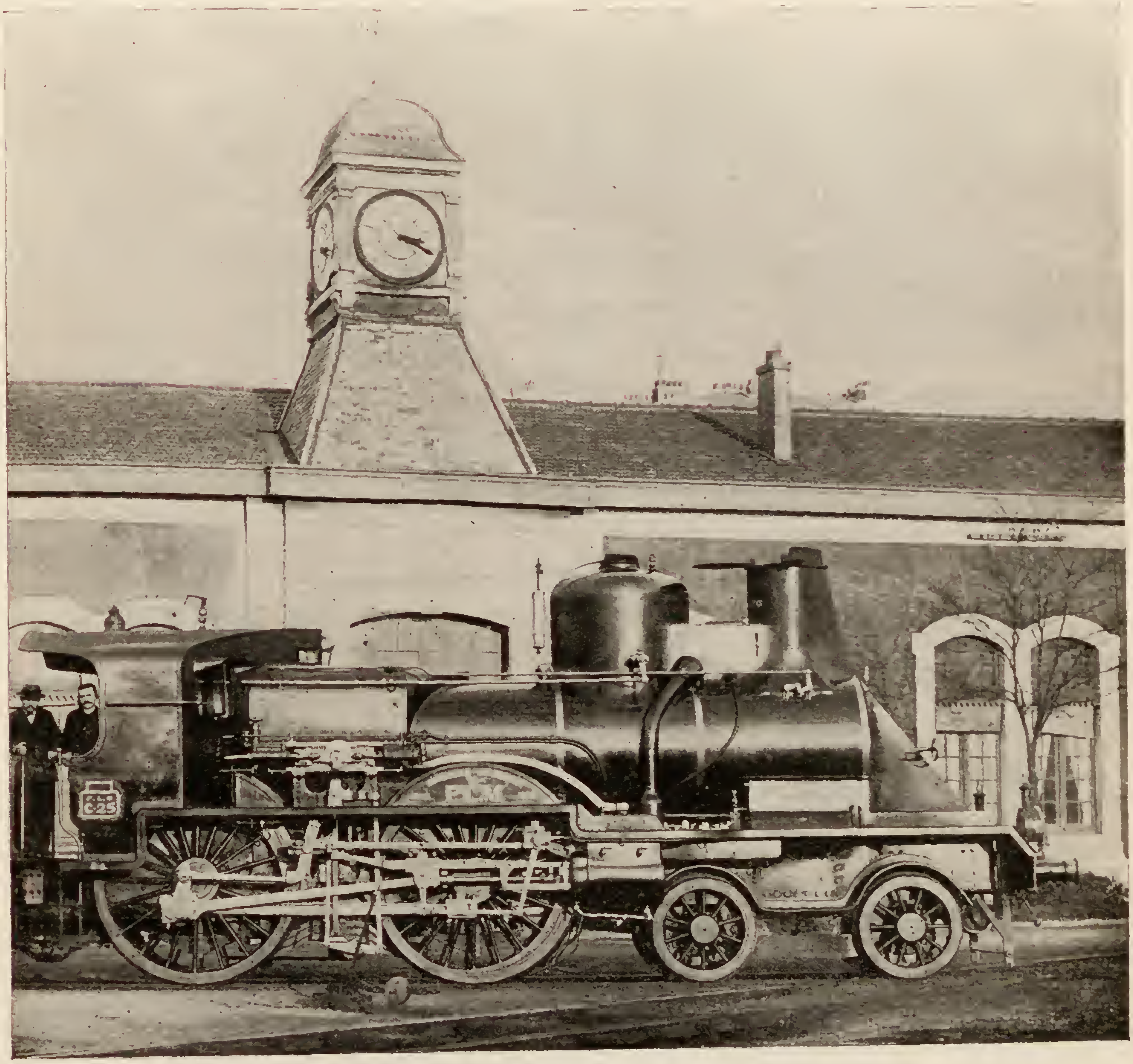
Truck, number of leaves	11
" width of leaves	5⅛ in.
" thickness of leaves	⅝ in.
" camber	2$\frac{9}{16}$ in.
Driving, number of leaves	19
" breadth	3$\frac{9}{16}$ in.
" thickness	⅜ in.
" camber	3⅜ in.

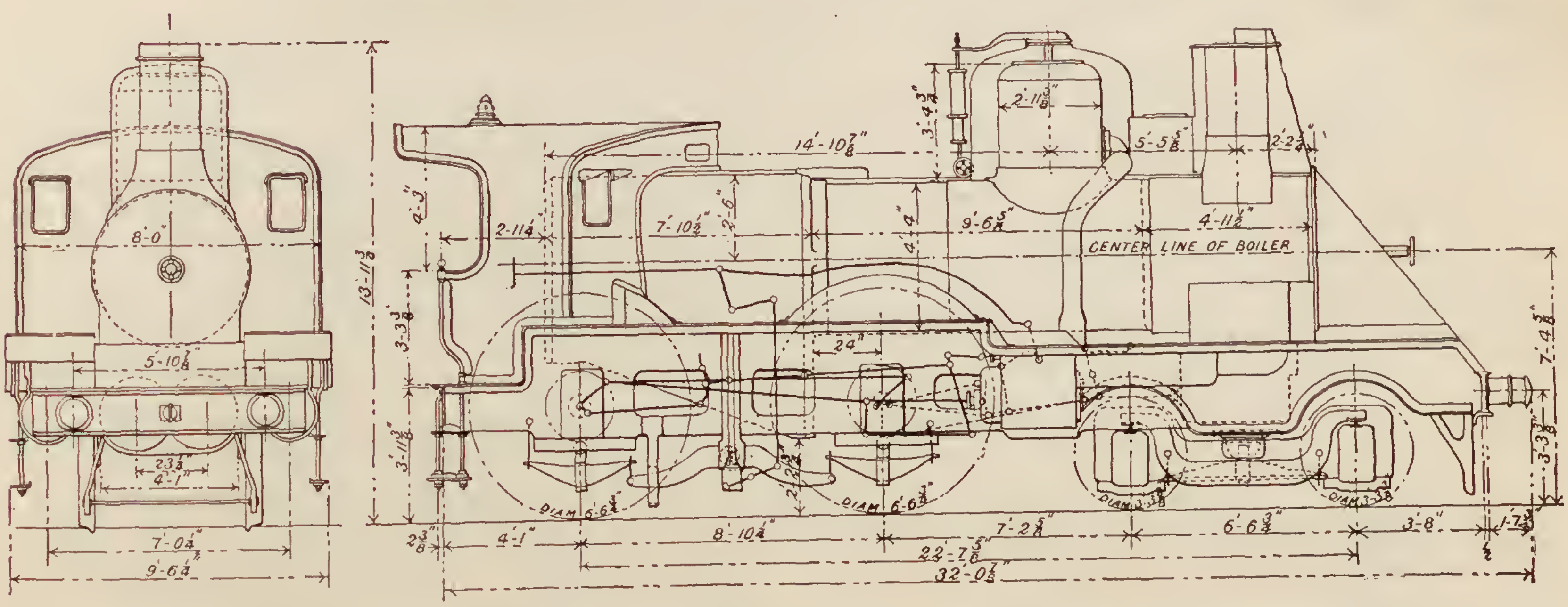
Valve Motion.

	High Pressure.	Low Pressure.
Diameter of cylinders	13⅜ in.	21¼ in.
Stroke of pistons	24⅜ in.	24⅜ in.
Centre to centre of cylinders	7 ft. ¼ in.	1 ft. 11¼ in.
Length of connecting rods	7 ft. 8½ in.	6 ft. ⅝ in.
Centre to centre of valve rods	7 ft. 2 in.	3 ft. 7⅝ in.
" " " " links	7 ft. 11$\frac{1}{16}$ in.	8⅞ in.
" " " " side rods		5 ft. 11½ in.
Angle between high-pressure cranks and low-pressure cranks	135 deg.	

Type of Valve Motion.

	Walschaert.	Gooch.
Kind of valve	Double-ported.	Double-ported.
Maximum stroke of valve	4⅞ in.	5⅞ in.
Outside lap	1 in.	1$\frac{5}{16}$ in.
Inside lap	None.	None.
Average maximum cut-off	72 5 per cent.	74.5 per cent.
Admission ports length	9$\frac{7}{16}$ in.	13 in.
" " width	1⅜ in.	1$\frac{1}{16}$ in.
Exhaust ports, length	9$\frac{7}{16}$ in.	13 in.
" " breadth	3⅛ in.	3$\frac{1}{16}$ in.
Capacity of receiver		8$\frac{1}{16}$ cu. ft.





COMPOUND EXPRESS LOCOMOTIVE WITH AIR PLOUGHS, ON THE PARIS, LYONS & MEDITERRANEAN RAILROAD.

EARLY AMERICAN LOCOMOTIVES BUILT IN ENGLAND.

Mr. Clement E. Stretton, the indefatigable investigator into locomotive history, has sent us the following lists of locomotives which were built in England by different makers, and sent to the railroads in this country which are named. This data will supply another link in the history of locomotives for the coming historian, whoever he may be. Most if not all of this interesting information was contributed by Mr. Stretton to the Baltimore & Ohio Railroad's interesting exhibit in Chicago at the Columbian Exhibition :

LIST OF LOCOMOTIVE ENGINES BUILT BY MESSRS. BENJAMIN HICK & CO. OF THE SOHO WORKS, BOLTON, AND SENT TO AMERICAN RAILROADS.

Date when Built.	Name of Engine.	Name of Railroad Company.
1834	Fulton	Pontchartrain.
1836	Potomac	Richmond, Fredericksburg & Potomac.
1837	Louisa	" " " "
1837	New Orleans	Carrollton.
1837	Virginia	Raleigh & Gaston.

LIST OF LOCOMOTIVE ENGINES CONSTRUCTED BY R. STEPHENSON & CO., NEWCASTLE-ON-TYNE, AND SENT TO AMERICN RAILROADS. COMPILED BY CLEMENT E. STRETTON, LEICESTER, FROM THE OFFICIAL RECORDS WHICH EXIST IN ENGLAND AND AMERICA, 1893 AND 1894,

Date When Built.	Maker's No.	Name of Engine.	Name of Railroad.	No. of Wheels.	Class of Engine.	Notes and Remarks.
1828	12	America	Dela`are & Hudson Canal Co	4	Cylinders outside	Built to the order of Horatio Allen.
1831	17	Whistler	Boston & Providence	4		Built to the order of Capt. Whistler.
1831	23	Delaware	Newcastle & Frenchtown	4	Cylinders inside	
1831	24 (?)	John Bull	Mohawk & Hudson	4	" "	
1831	25 (?)	Stevens—John Bull	Camden & Amboy	4	" "	Name changed from "Stevens" to "John Bull" on arrival in America, 1831. (At Chicago Exhibition, 1893.)
1832	27	Boston	Boston & Worcester	4	Cylinders inside	Built to the order of Mr. Jackson.
1832	28	Phœnix—Maryland	Newcastle & Frenchtown	4	" "	Name changed from "Phœnix" to "Maryland," 1832.
1832	5	Pennsylvania	" " "	4	Cylinders inside	Maker's No. appears out of order.
1832	7 (?)	Herald	Baltimore & Susquehanna	4	" "	A leading bogie placed under this engine on its arrival in America, 1832.
1832	8 (?)	Stephenson	Boston & Lowell	4	Cylinders inside	
1833	42	Davy Crockett	Saratoga & Schenectady	6	4-wheeled bogie and 1 pair of drivers	A second pair of drivers added, 1835–1836.
1833	52	Virginia	Newcastle & Frenchtown	4	Cylinders inside	
1833	54	Edgefield	South Carolina	4	" "	A 4-wheeled bogie added in America, 1834.
1833	60	Brother Jonathan	Mohawk & Hudson	4	Cylinders inside	
1833	61	Robert Fulton	Mohawk & Hudson	4	" "	
1833	75	Fire Fly	Saratoga & Schenectady	6	4-wheeled bogie and 1 pair of drivers	
1834	87	William Aiken	Charlestown & Columbia	4	Cylinders inside	A 2-wheeled truck added in America in 1835.
1834	99	Elias Hony	Charlestown & Columbia	4	Cylinders inside	
1834	103	Richmond	Richmond, Fredericksburg & Potomac	4	" "	
1834	104	Pennsylvania	Pennsylvania (Portage Division)	6	4-wheeled bogie and 1 pair of drivers	A second pair of drivers added, 1836
				6	" " " 1 " " "	
1834	105	Philadelphia	" " "	6	" " " 1 " " "	
1834	106	H. Schultz	Charlestown & Columbia	4	Cylinders inside	
1834	107 (?)	Meteor	Boston & Worcester	4	" "	Pennsylvania Railroad—Philadelphia Division.
1835	110	Kentucky	Philadelphia & Columbia, P. R.R.			
1835	112	John Bull	Philadelphia & Columbia, P. R.R. (Philadelphia Division)	4	Cylinders inside	A 4-wheeled bogie added, 1837.
1835	113	Atlantic	Philadelphia & Columbia, P. R.R. (Philadelphia Division)	4	" "	
1835	114	Sumter	South Carolina	6	4 wheeled bogie and 1 pair of drivers	A second pair of drivers added, 1837–38.
1835	115	Marion	South Carolina	6	" " " 1 " " "	
1835	116	Ohio	" "	6	" " " 1 " " "	
1835	117	Comet	Boston & Worcester	4	Cylinders inside	A 4-wheeled bogie added in America, 1835.
1835	119	Rocket	Boston & Worcester	4	Cylinders inside	A 2-wheeled truck added in America, 1836.
1835	120	Mercury	Boston & Worcester	4	Cylinders inside	
1836	121	Jupiter	" " "	4	" "	
1836	125	Wayne	Wilmington & Raleigh	4	" "	Another pair of drivers added in America.
1836	126	Nash	Wilmington & Raleigh	4	Cylinders inside	
1836	129	Nottoway	Lexington & Ohio	4	" "	
1836	139	Elkhorn	" " "	4	" "	
1837	151	Baltimore	Baltimore & Susquehanna	6	1 pair small and 4 coupled drivers	On arrival in America the front small wheels were taken out and a 4-wheeled bogie put in; they then had eight wheels.
1837	152	Susquehanna	" " "	6	1 " " " 4 " "	

The following is a list of the names and dates of construction of locomotives which were built by Messrs. Tayleur & Company, of the Vulcan Foundry, near Warrington, and sent to the railroads in this country, the names of which are given :

Date when Built.	Name of Engine.	Name of Railroad Company.
1833	Fire Fly	Camden & Woodbury.
1833	Red Rover	" " "
1835	Cincinnati	South Carolina.
1835	Allen	" "
1835	Kentucky	" "
1836	Gaston	Raleigh & Gaston.
1836	Raleigh	" " "

LIST OF LOCOMOTIVE ENGINES BUILT BY MESSRS ROTHWELL & CO. OF THE UNION FOUNDRY, BOLTON, AND SENT TO AMERICAN RAILROADS.

Date when Built.	Name of Engine.	Name of Railroad Company.
1832	Pontchartrain	Pontchartrain.
1833	Noltoway	Greenville & Roanoke.
1836	Pioneer.	Bangor & Piscataqua.
1836	Bangor	" " "
1836	Tennessee	South Carolina.
1837	Robert Morris	Richmond, Fredericksburg & Potomac.
1837	Oliver Evans	" " " "

LIST OF LOCOMOTIVE ENGINES BUILT BY MESSRS. EDWARD BURY & CO., OF THE CLARENCE FOUNDRY, LIVERPOOL, AND SENT TO AMERICAN RAILROADS.

Date when Built.	Name of Engine.	Name of Railroad Company.
1831	Liverpool	Petersburg.
1832	Roanoke	Richmond, Fredericksburg & Potomac.
1833	Meherrin	Raleigh & Gaston.
1833	Appomattox	" " "
1833	Creole	Pontchartrain.
1834	Staunton	Raleigh & Gaston.
1834	Petersburg	" " "
1834	Georgia	South Carolina.
1834	Augusta	" "
1835	Boston	Boston & Providence.
1835	Augusta	Richmond, Fredericksburg & Potomac.
1835	Fredericksburg	" " " "
1836	Lion	Boston & Worcester.
1836	Wilmington	Philadelphia & Wilmington.
1836	Orleans	Pontchartrain.
1837	John Randolph	Richmond, Fredericksburg & Potomac.
1837	Sheppard	" " " "
1837	Stafford	" " " "
1837	Patrick Henry	" " " "
1837	Roanoke	Raleigh & Gaston.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.

SECOND SERIES.—CHEMICAL METHODS.

XII.—METHOD OF DETERMINING CHLORIDE IN AMMONIUM CHLORIDE.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(*Continued from page* 521.)

OPERATION.

Put about half a gram of the ammonium chloride into a 12-oz. beaker, and add 25 c.c. of distilled water. Allow to dissolve and then add 3 drops of a neutral solution of normal chromate of potash, and then solution of sodium carbonate until the liquid is faintly but clearly alkaline to litmus paper. Now run in from a burette standard silver nitrate solution, accompanied by vigorous stirring with a glass rod, or shaking of the beaker until the last drop of silver solution leaves a permanent red color. Read off the number of c.c. of silver solution used, and from these calculate the amount of chlorine present.

APPARATUS AND REAGENTS.

The apparatus required by this method needs no especial comment.

The normal potassium chromate solution is made by dissolving 10 grams of the C. P. salt in 100 c.c. of distilled water, and filtering if necessary.

The sodium carbonate solution is made by dissolving 20 grams of the dry C. P. salt in 100 c.c. of distilled water, and filtering if necessary.

The standard silver nitrate solution is made by adding 68 grams of crystallized C. P. silver nitrate to 2 litres of distilled water, allowing to dissolve, and then adding 5 drops of concentrated C. P. nitric acid. This solution is standardized as follows: Prepare first some pure sodium chloride by dissolving 100 grams of C. P. sodium carbonate in a slight excess of dilute hydrochloric acid, filtering into a royal Berlin porcelain dish, and allow to crystallize, carefully covered, in a warm place until half of the salt has crystallized out. Drain off the mother liquor, dissolve the crystals in distilled water, and crystallize again until half the salt has crystallized out. Carefully drain off the mother liquor and wash the crystals once with distilled water, then transfer to a clean platinum dish and carefully ignite at a temperature not above 400° F., to drive off moisture. Transfer the still warm salt to a carefully dried and closely stoppered weighing tube for use. After the weighing tube has become cold by remaining some time in the balance case, remove the cork to allow the air pressure to equalize, then replace it securely and weigh. Open now the tube and shake out into a 12-oz. beaker about 0.300 gram of the salt, quickly replace the cork again and weigh. The difference in the two weights shows the amount of salt taken. Suppose this to be 0.3288 gram. Dissolve the salt in about 25 c.c. of distilled water, add 3 drops of the chromate of potash solution, and enough of the sodium carbonate solution to render the liquid faintly but clearly alkaline to litmus paper. Now run in from the burette the silver nitrate solution with thorough agitation, either by stirring or shaking, until the last drop gives a permanent red color. Read off the number of c.c. of silver nitrate solution used. Suppose that 28.1 c.c. are required. Then since 60.68 per cent. of the sodium chloride is chlorine, it is evident that 28.1 c.c. of the silver nitrate solution is equivalent to [$0.3288 \times .6068$] 0.1995 gram of chlorine, or 1 c.c. of the silver nitrate solution is equivalent to [$0.1995 \div 28.1$] 0.0071 gram of chlorine. Not less than two independent determinations of the strength of the silver nitrate solution should be made, and the duplicates should agree as to the strength of 1 c.c. of the solution within 0.00003 or 0.00004 gram.

CALCULATIONS.

Atomic weights: used sodium, 23; chlorine, 35.5; silver, 108; nitrogen, 14; oxygen, 16; hydrogen, 1. Molecular formulæ: sodium chloride, $NaCl$; silver nitrate, $AgNO_3$; ammonium chloride, NH_4Cl. Suppose the amount of silver nitrate solution used in an actual determination is 46.4 c.c. Then since each c.c. equals 0.0071 gram of chlorine, the total amount of chlorine present is [46.4×0.0071] 0.3294 gram, and if 0.4998 gram was taken to start with, the percentage of chlorine will be [$0.3294 \times 100 \div 4998$] equals 65.91 per cent.

NOTES AND PRECAUTIONS.

It will be observed that this method dissolves the ammonium chloride in water, renders the solution distinctly alkaline with sodium carbonate, and then measures the amount of chlorine by means of a slightly acid silver nitrate solution using normal potassium chromate as indicator.

A rather large beaker is recommended, so as to enable the solution to be thoroughly agitated during the titration without danger of loss.

If the solution is not very thoroughly agitated during the titration, the coagulated precipitate of silver chloride is apt to retain some of the ammonium chloride solution, giving rise to low results. The agitation should be sufficient to break up the silver chloride into very small particles. The standard solution should be added very slowly at the last.

If the silver solution is entirely neutral, especially if it is exposed to the light, it is apt to change and slowly lose strength. This is apparently completely obviated by the presence of a little free nitric acid. But this free nitric acid introduces difficulty with the potassium chromate if the ammonium chloride solution is strictly neutral. Accordingly a small amount of sodium carbonate is introduced into this solution. The amount of this sodium carbornate must be enough to completely neutralize the free nitric acid, and a small excess introduces no difficulty.

WATER-TUBE BOILERS AND THEIR APPLICATION TO WAR VESSELS.*

By J. Nastoupil.

(*Continued from page* 551, *Volume LXVIII.*)

VI. The Niclausse water-tube boiler (figs. 17–19), as built by the *Société anonyme des générateurs inexplosibles* at Paris, consists of a series of vertical front tubes standing near each other, and a number of inclined water tubes which have their open ends fastened into the shells of the front tubes and are extended back into the furnace, where they are exposed to the action of the gases of combustion. Each front tube is connected at the top with a single steam drum, which in working conditions is half full of water.

Each front tube, which is made of malleable iron, is divided by a partition wall into two compartments. While at work a mixture of steam and water enters the inner chamber from the heating tube and rises into the drum, flowing down again through the outer chamber, and thence as cool water out into

* Paper read before the Wissenschaftlichen Verein der k. und k. Kriegsmarine.

the heating tube through the inner tube that is screwed into the partition wall.

VII. The Dürr water-tube boiler (fig. 20), as it is built by Dürr & Co., in Radingen, and by Dürr, Gehre & Co., in Mödling, near Vienna, reminds one of the Lane water-tube boiler as applied to the purposes of stationary work.

It consists of an iron water chamber or leg, whose flat surfaces are strengthened and held together by stay-bolts. The inner space is divided into two parts by a vertical plate. At the upper end this water leg is connected with one or more steam chambers that are either conical or cylindrical, and which are kept about half full of water when in service; at the back end the boiler is arranged with blow-off cocks and facilities for cleaning.

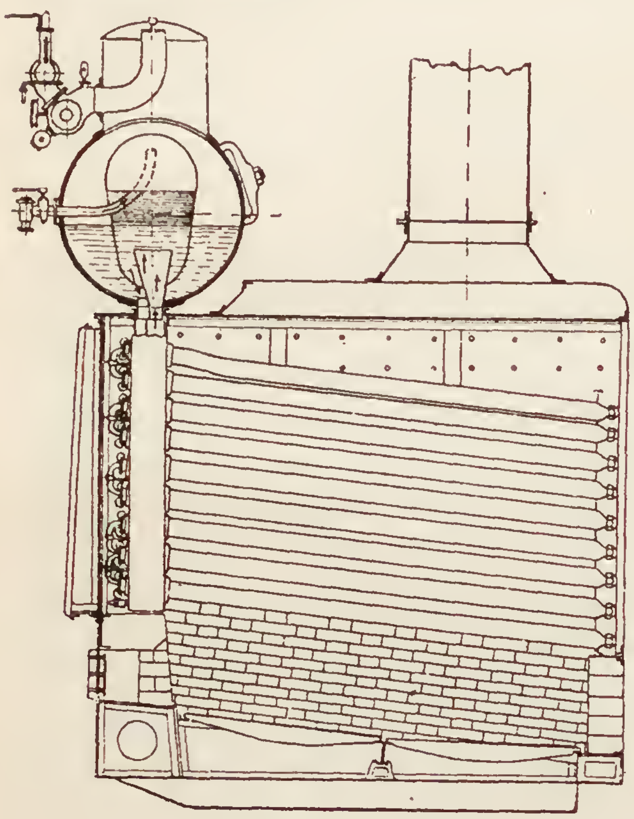


Fig. 17.

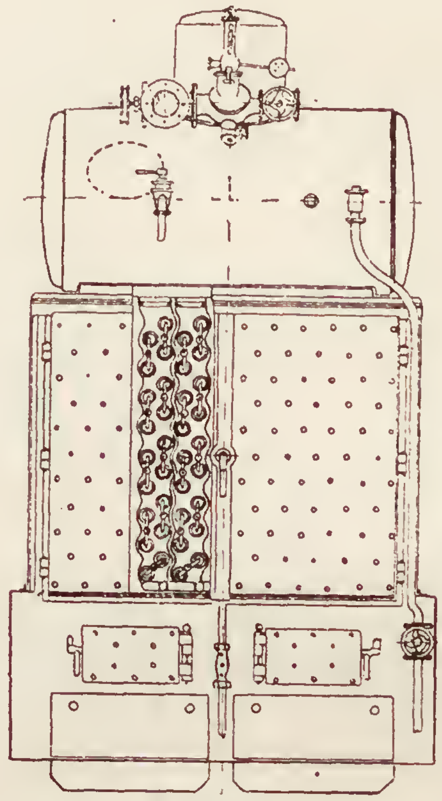


Fig. 18.

THE NICLAUSSE BOILER.

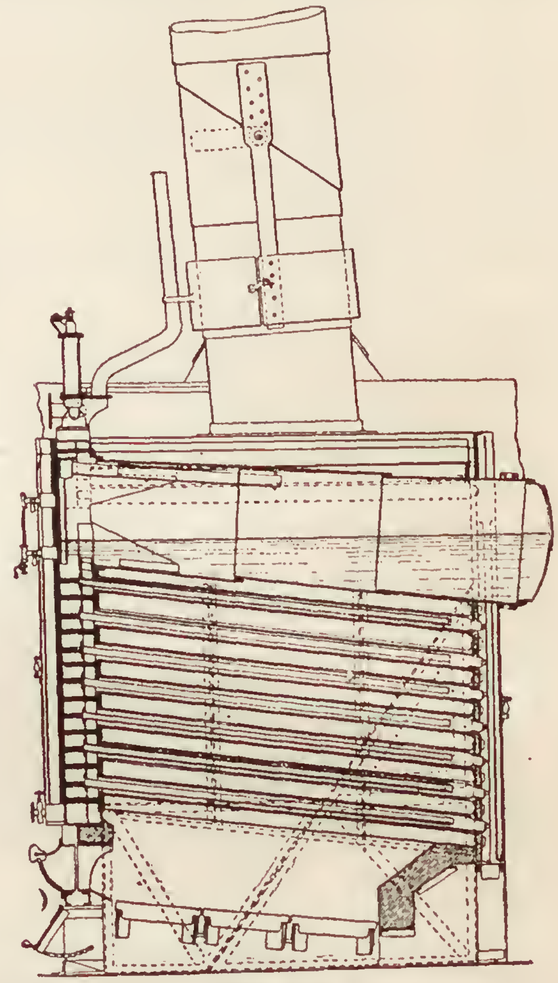


Fig. 20.

THE DÜRR BOILER.

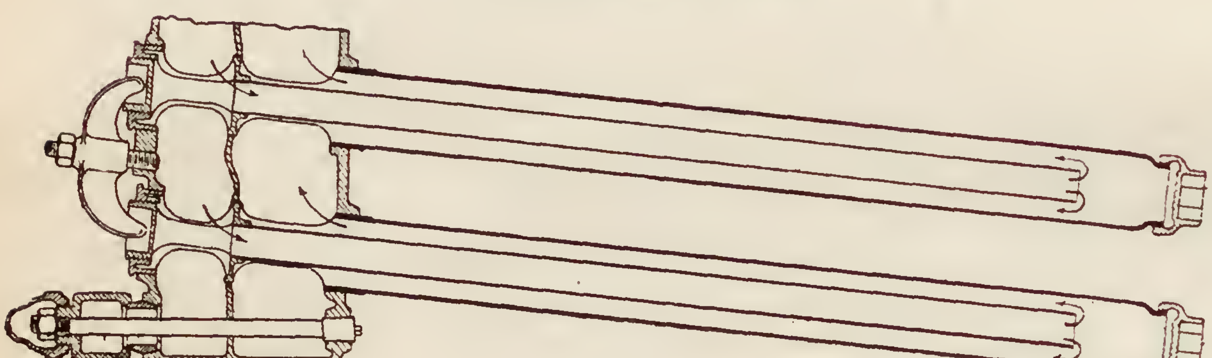


Fig. 19.

AN ELEMENT OF THE NICLAUSSE BOILER.

Into the back or inner sheet of the water leg a number of tubes are fastened, arranged in inclined rows, and each, whose back ends are set in an iron sheet, protected by fire-brick. Welded ferrules are used for fastening the tubes into the tube-sheet, which with their conical flanged openings are pressed into that sheet. As the centre line of the tube is inclined to the tube-sheet, it follows that the ferrule must be somewhat distorted, so that its centre line makes a corresponding angle with the centre line of the tube.

Conical internal plugs are used for closing the ends of the tubes, and these slip into conical seats, where they are held by means of screw-bolts. The possibility of drawing out is provided for by the ring-shaped opening; the hollow form of the closing piece affording the necessary elasticity.

The circulation of the water is provided for in the generating tubes. The inner tubes are fastened to the dividing partition set in the water leg, while their back ends open near the closed end of the outer tubes, so that the cooler water flows down through the outer half of the water leg, enters the inner tube and passes out through the outer tube into the back side of the water leg, and then rises to the steam drum.

Between the two steam drums, or, when only one is used, placed in the form of a half circle about it is a superheater, which, like the boiler itself, consists of a double chamber or drum and a nest of tubes.

In order to prevent external radiation as much as possible, the generating tubes are placed close together along both sides of the boiler, and the spaces necessarily left between the tubes and down to the grate-bars are filled with fire-brick. The whole boiler rests upon a wrought-iron base, and is well protected with a sheet-iron jacketing, through which the stops for the tubes are perfectly accessible by means of the doors that are provided.

While in service the circulation of water takes place, as already noted—that is, the water is heated in the generating tubes, and flows into the back portion of the water leg, through which it rises, while an equal quantity flows into the internal tubes from the front half of the water leg.

The steam generated in the boiler passes out of the steam drum into the front portion of the superheater, passes thence through the internal tubes into the superheating tubes, in which it is thoroughly dried and superheated to a greater or less extent, and then comes back to the back portion of the superheater, whence it is drawn for use.

The tubes are cleaned of the accumulation of rust and dirt by using the openings at the ends that are closed while in service and by means of a flexible steam hose.

In torpedo-boats the steam drum is omitted, and in order to secure the requisite steam space the water leg is correspondingly widened, and the steam taken from this point directly into the superheater, from which it in turn goes to the steam-pipe.

VIII. The Yarrow boiler* (figs. 21, 22) is built by Yarrow & Co., at Poplar, and consists of three cylindrical vessels placed at the corners of an equilateral triangle, whose base is occupied by the grates. Each side vessel consists of two parts, which are fastened together by means of flanges and stay-bolts, and with the joints made tight by means of copper wire. The two lower parts, which lie on either side of the grates as water spaces, are connected to the steam drum at the top by a number of straight tubes. In order to allow for the insertion of the greatest possible number of tubes, the faces of the lower spaces where the tubes enter are made flat.

At first these water tubes were made of steel and galvanized for the sake of protection, but since then the firm have

* See American Engineer and Railroad Journal for June, 1894.

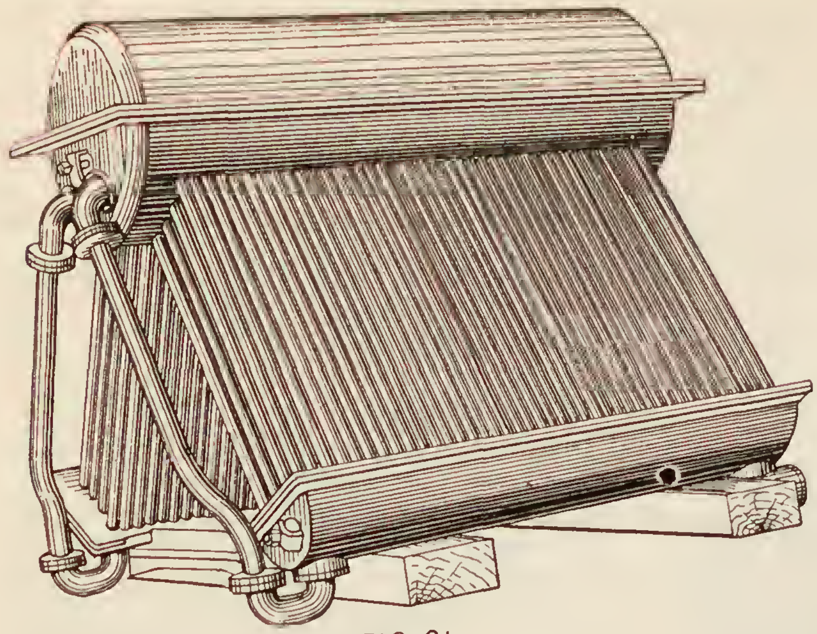


FIG. 21.

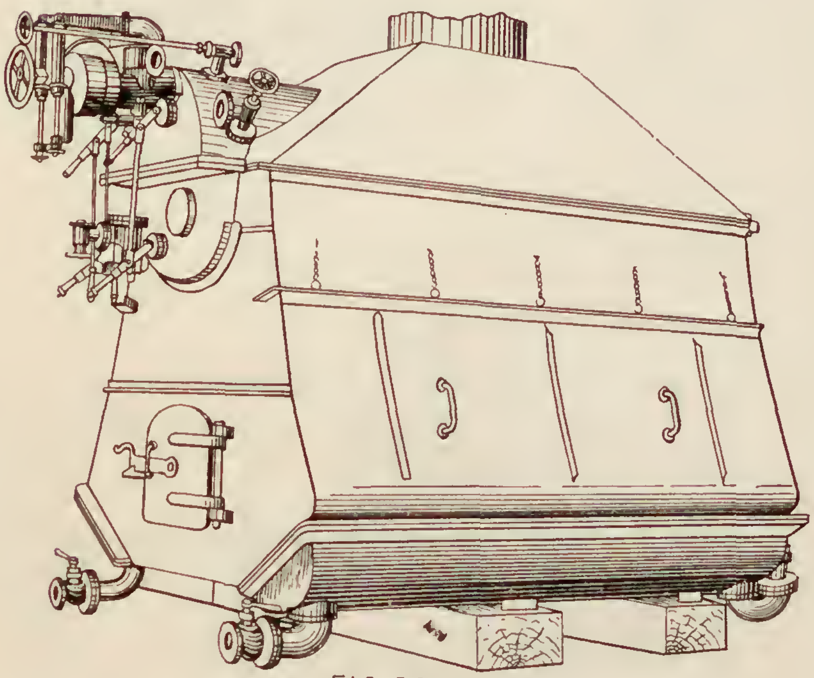


FIG 22.

THE YARROW BOILER.

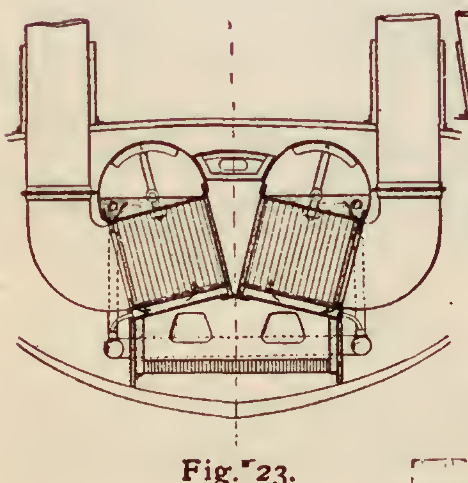


Fig. 23.

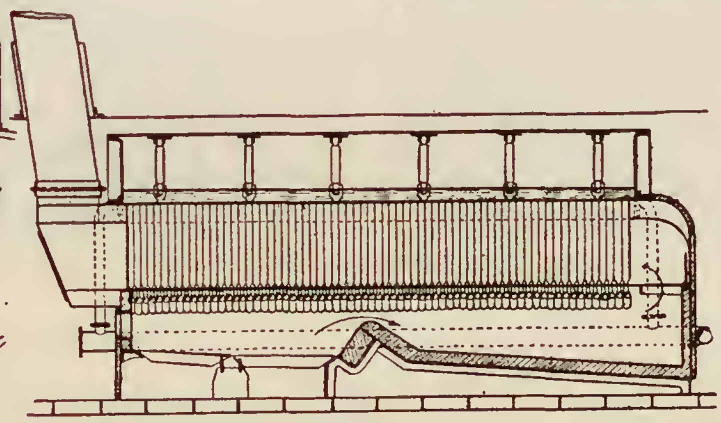


Fig. 24.

THE SAMPSON BOILER.

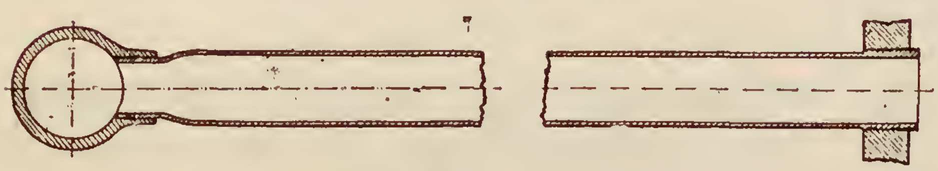


Fig. 25.

TUBE FASTENINGS OF THE SAMPSON BOILER.

adopted the use of copper tubes 1 in. in diameter, which are expanded at the ends and thus made tight in the tube-sheets.

By separating the upper and lower portions of the lower chambers, the tubes on both sides are made accessible, and therefore can be inspected and cleaned as far as their small diameter will permit. The whole boiler is encased in a covering, which usually consists of sheet iron, so that the outside of the tubes can be readily cleaned of rust and ashes.

The products of combustion, rising from the grates, pass between the tubes forming the nests on either side, and thence upward into the smoke-box, whence they escape into the stack.

While in service the water is maintained at such a height as to about half fill the steam drum, so that the upper ends of the tubes are submerged. Outside of the casing there are circulating tubes, which connect the water space of the steam drum with the two lower water spaces, but which have been dispensed with in the more recent constructions, since it has been found that a sufficient circulation of water is maintained through the water tubes of the boiler. Through those tubes which lie next to the fire, and which are subjected to the first impact of the products of combustion, there flows a mixture of steam and water upward into the steam drum, while the water flows down from the latter through those tubes which are relatively farther away from the fire and which are therefore cooler.

IX. The Sampson boiler (figs. 23–25), which is built by Mandslay, Sons & Field, Limited, of London, differs in the arrangement of its water tubes from those which have been described heretofore. It consists of double sets of cross and vertical tubes, each of which is connected with a steam drum. Above an ordinary furnace there are two nests of straight tubes arranged on an incline like a roof; each of these nests of tubes contains about 55 cross tubes with an outside diameter of 3 in., which, by a similar but opposite inclination, form the two sloping sides of the roof by which the furnace is closed at the top. Above each set of tubes there are two cylindrical vessels with a segment cut out of the cross-section, and whose lower flat surfaces are parallel to the inclination of the roof tubes already mentioned. Each cross tube is connected to the flat face of the steam drum that lies above it by 13 tubes that are $1\frac{1}{4}$ in. outside diameter and 2 ft. 3 in. long; of these there are 12 inner, which are protected from the outside by a sheet-iron diaphragm, while the thirteenth or outer tube remains with its outer half exposed to the smoke-box.

The lower open ends of the cross tubes are connected with a tube of larger cross-section by means of elbows, which surrounds the lower portion of the boiler, and is put in communication with the lower corners of the steam drum by means of four vertical tubes. The feed-water is pumped into these tubes, a portion of which goes to supply evaporation in the cross tubes, while the remainder rises into the steam drum.

The water that is heated in the cross tubes flows up through the vertical tubes as a mixture of steam and water into the steam drum. In order to check this flow of water in the vertical tubes, they are provided with retarders. The water that thus rises into the steam drum is diffused throughout the water space, where it mingles with the fresh feed-water, and out to the vertical tubes that lie outside the casing, and through them to the cross tubes, from which it again takes its upward course. A sheet-iron trough is also arranged along the whole length of the steam drum for the purpose of regulating the circulation.

The furnace has two doors to facilitate firing; the hot gases pass from the furnace proper beneath the cross tubes to the combustion chamber, and then, making a complete turn, pass through the space occupied by the vertical tubes to the smoke-box situated at the front end, from which they go directly into the stack. It will thus be seen that the boiler consists essentially of two symmetrical and independent halves, and that one half can be closed for cleaning the fire while in service by closing the corresponding dampers and shutting off the combustion chamber at the back end; the products of combustion then flow through the other half of the boiler.

The lower combustion chamber, as well as the smoke passages through the nest of vertical tubes, can be cleaned with brushes through suitable openings that have been provided. The cleansing of the interior of the water tubes is also effected partially from the steam drum above and partially through the cross tubes. No pipe connection is subjected to the direct action of the flame, and damaged or worn-out tubes can easily be replaced by reserve tubes; and in like manner the whole boiler can be re-

newed without the necessity of opening the deck of the vessel.

X. The Thorneycroft water-tube boiler (figs. 26–28), like the Yarrow boiler, consists of three horizontal cylindrical vessels arranged in the form of an equilateral triangle. The upper chamber, which forms the steam drum, is connected with the lower or water drums inside the casing by a number of curved tubes, and outside the casing by strong circulating tubes. The heating tubes have a diameter of from 1 in. to 1¼ in., and are fastened at their ends by rolling out; and while in service their upper ends are kept above the water-level in the steam drum.

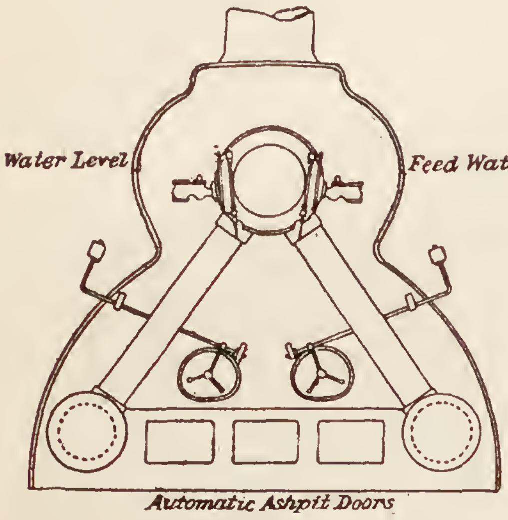


Fig. 26.

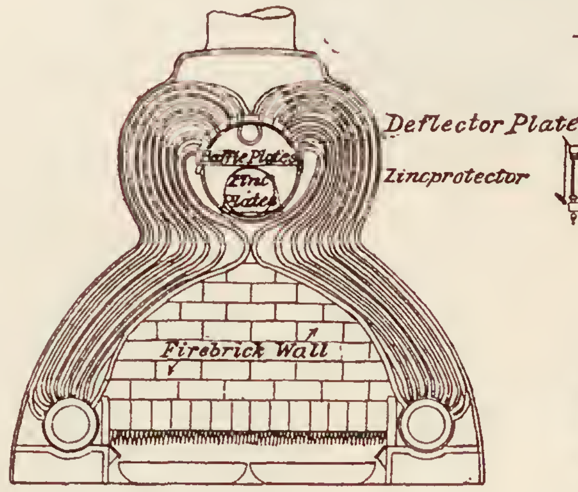


Fig. 27

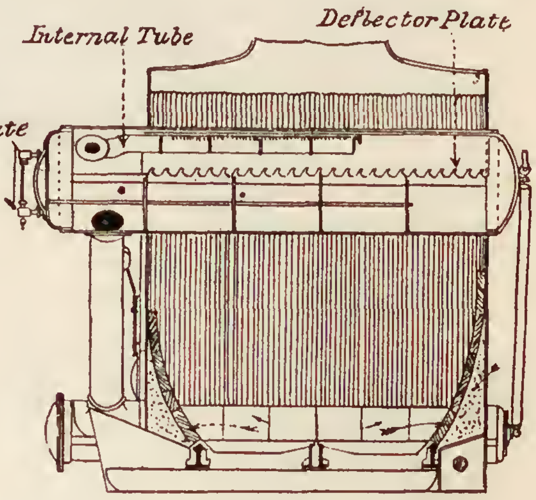


Fig. 28.

THE THORNEYCROFT BOILER.

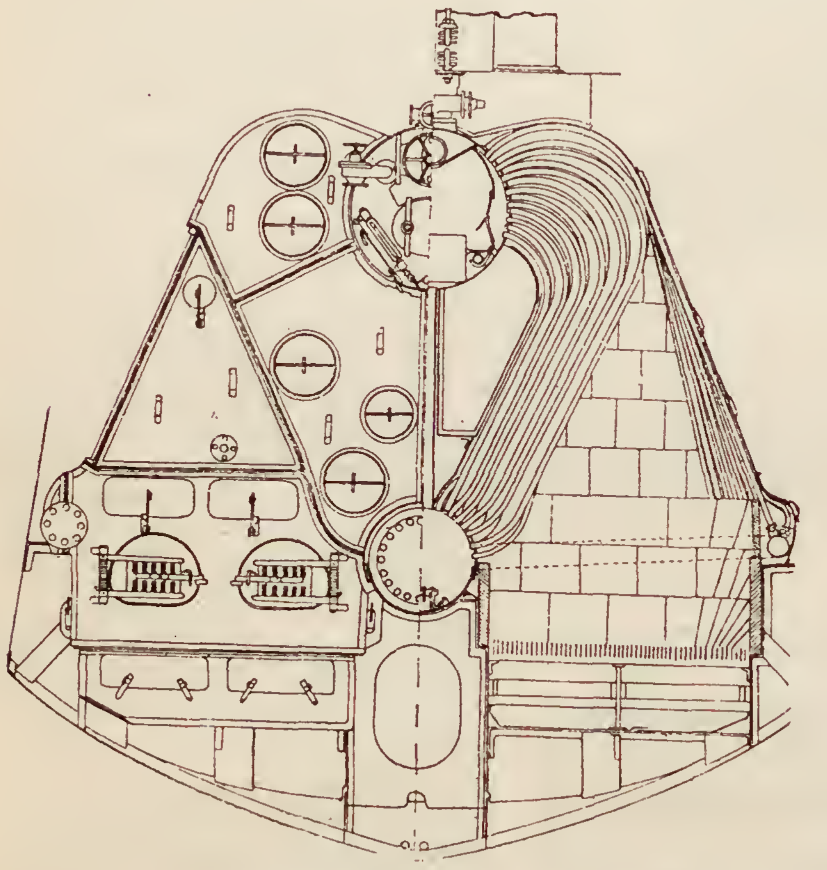


Fig. 29.

THE NEW THORNEYCROFT BOILER

In consequence of the heating of the water contained in the thin tubes, it rises into the boiler and produces a rapid circulation.* The mixture of steam and water pouring out of the heating tubes into the steam drum strikes against a deflector plate, by which the water is thrown down. The water accumulating on the bottom of the steam drum, which is here mingled with the feed-water, flows down through the outside circulating pipes and through the water chambers to the water tubes.

The Thorneycroft Company also build their boiler in another form, which is especially adapted to the purposes of combined boilers. This form of boiler (figs. 29, 30) consists of a large horizontal water drum and a steam drum lying above it, which are joined at the sides by several sets of curved heating tubes, and in the centre line by a further row of circulating tubes.

The furnaces are disposed on either side of the water drum. For the protection of the side casing, which is of sheet metal, there is a special wall of tubes, which consists of separate, curved, closely set heating tubes; they connect with a special water tube, which forms a sort of drum on one side of the main drum, while their upper ends open into the main steam space.

The external cleaning of the tubes in this boiler is somewhat difficult, while the internal cleaning is next to impossible. It is therefore its efficiency, coupled with the light

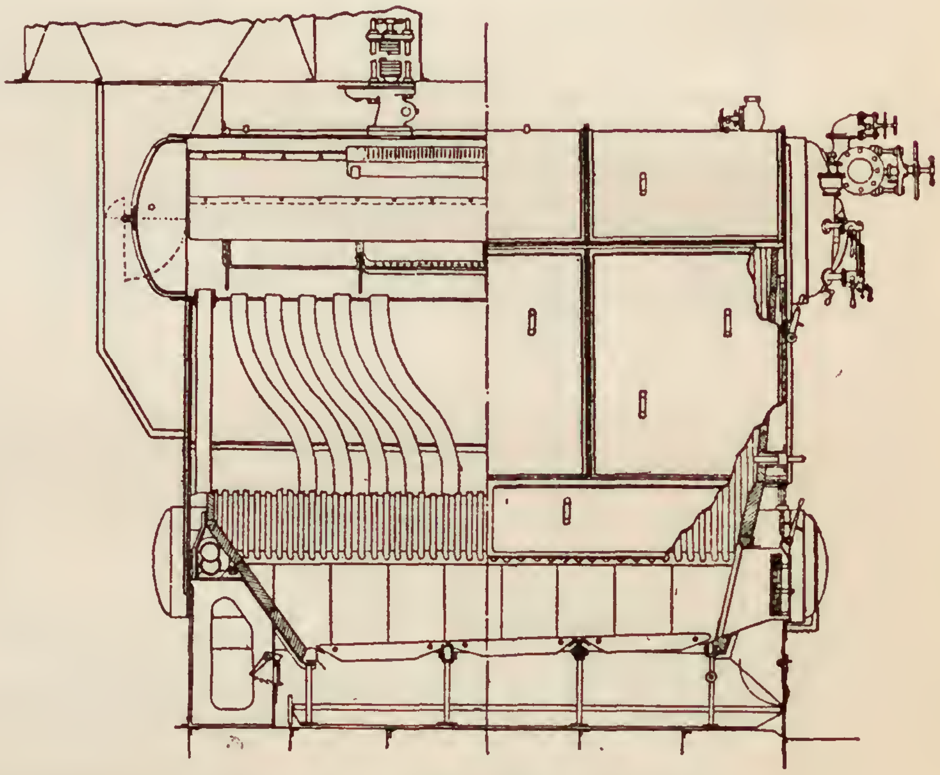


Fig. 30.

THE NEW THORNEYCROFT BOILER.

weight and great economy in the consumption of coal, that has brought this boiler to the front, so that it is especially adapted for places where the minimum weight and maximum steam production must be obtained for a short time.

(TO BE CONTINUED.)

* See American Engineer and Railroad Journal, September, 1894, page 410.

AN EXPERIMENTAL STUDY OF THE EFFECT OF THE COUNTERBALANCE IN LOCOMOTIVE DRIVE-WHEELS UPON THE PRESSURE BETWEEN WHEEL AND RAIL.*

By W. F. M. Goss.

In the mechanism of a locomotive, the revolving parts at the crank-pins, together with the reciprocating parts connected therewith, are balanced more or less completely by the

* Paper presented at the New York meeting (December, 1894) of the American Society of Mechanical Engineers.

addition of masses, or "counterweights," to the drivers. But since the counterweights move in circular paths, it is only the horizontal component of the radial force derived from them which can serve to neutralize the effect of the reciprocating parts; the vertical component of all that portion of the force which applies to reciprocating parts is unbalanced. This unbalanced vertical component causes the pressure of the driver on the rail to vary with every revolution. Whenever the speed is high, it is of considerable magnitude, and its change in direction is so rapid that the resulting effect upon the rail is not inappropriately called a "hammer blow." Many practical demonstrations have been had of the magnitude of the forces involved. Heavy rails have been kinked, and bridges have been shaken to their fall, all under the action of heavily balanced drivers revolving at high speeds. The evidence is sufficient, but the means by which the evil is to be overcome has not yet been made clear. Indeed, the difficulties to be met in counterbalancing have been greatly increased by the demand during the last decade for heavier and still heavier engines, and for higher speeds in all classes of service. Heavier engines require heavier reciprocating parts, and heavier reciprocating parts demand more counterbalance. With a view to keeping the speed of rotation down, wheel diameters have been somewhat increased; but the expected gain has not been realized, because an increase of speed has followed. As a result of these developments, the modern engine may have reciprocating parts on each side weighing from 600 to 1,000 lbs.; these must be given a horizontal balance (more or less complete) by counterweights in the wheels, and the wheels are often driven at a rate exceeding 300 revolutions a minute.

It is not the purpose of this paper, however, to discuss the question of counterbalancing, but rather to show some of the effects of such balancing. The forces which are brought into action by the presence of the counterbalance have been elaborately studied; and their precise effect upon the pressure of contact between wheel and rail have of late been the subject of considerable discussion. To throw some light upon this most practical and important question, a series of experiments was undertaken at the engineering laboratory of Purdue University, the essential feature of which was the passing of a soft iron wire of small diameter under the moving wheel. It was expected that the varying thickness of the wire which had been subjected to this process would show the effect of variation in pressure between the wheel and the track. If the wheel should leave the track entirely, a portion of the wire would retain its full diameter; and the real purpose of the experiments, as originally planned, was to demonstrate whether at any speed easily attained the driver would actually rise from the track. Brief accounts of these experiments have already been published, and the interest which has been shown in them has prompted this more complete statement of the conditions involved, and the results obtained.

The apparatus employed consisted chiefly of the Purdue locomotive *Schenectady*, which, as is generally known, is mounted with its drivers resting upon wheels of approximately the same diameter with the drivers. When the drivers are turned by the engine, the supporting wheels roll in contact with them, the engine as a whole remaining stationary.

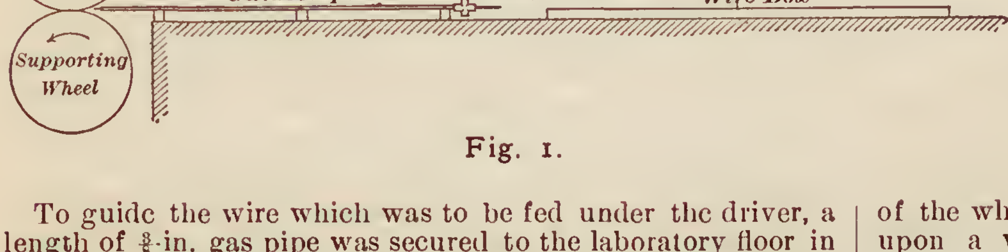


Fig. 1.

To guide the wire which was to be fed under the driver, a length of ⅜-in. gas pipe was secured to the laboratory floor in front of each driver included in the experiment (fig. 1). Three pipes were thus arranged. A deflector plate was fixed behind the main driver, to turn the wire delivered from this wheel away from the rear driver; but, except for this plate, no attempt was made to control the course of the wire after it left the wheel. The wire was of common annealed iron of about 0.037 in. in diameter. It was prepared by being carefully straightened and cut into lengths of 20 ft.—that is, about 3.5 ft. longer than the circumference of the drivers, and 2 in. longer than the guide-pipe in which the lengths were to be fed to the wheels. Wires thus prepared were laid in light wooden troughs to preserve them from injury, and a trough thus supplied was placed in line with each guide-pipe (fig. 1). In conducting the experiments, an operator at each pipe drew a wire from the trough and passed it into the pipe until only about 2 in. of the length remained outside. From the relative length of guide tube and wire, it was known that the opposite end of the latter was now close to the driver. When desired conditions of speed had been secured and a signal given, a touch of the operator's finger upon the end of the wire was sufficient to start the opposite end under the wheel. The starting of the wire was accomplished without commotion. The man in charge was conscious only of having touched it. To an observer who watched for the wire as it came from the driver, it gave the impression of a quivering beam of light, which an instant later became a loosely tangled thread of metal. Or, if one kept his eye upon the wall of the laboratory against which the wire was allowed to impinge, he saw the whole tangled coil appear instantaneously and without apparent cause. The initial end of each wire was, in plan, of the outline shown by fig. 2, from which it would appear that when the wire came under the influence of the wheel's motion, the tensional stress upon sections near the end, as at A, exceeded the elastic limit of the material, this stress being required to impart motion to the mass of wire to the right of A. The weight of the 20-ft. length was about 1 oz., and the time occupied in its passage was usually a fifth of a second. These facts will help to show the significance of the speeds used in the experiments.

Fig. 2.

The speed of the locomotive was noted from a registering counter, and also by a Boyer speed recorder, a permanent record being obtained from the latter instrument. To assist in connecting the effect produced on the wire with definite phases of the wheel's motion, a nick was made with a sharp chisel across the face of each driver, in line with the counterweight, as at A (fig. 3). An impression of this nick was sharply defined upon every wire that passed under it. The initial end of the wire could, as has been already stated, be determined by an examination; but to leave no doubt as to this matter, and for the purpose of giving a second reference point, one of the wheels was marked with two parallel lines 90° from the first reference line, as at C (fig. 3).

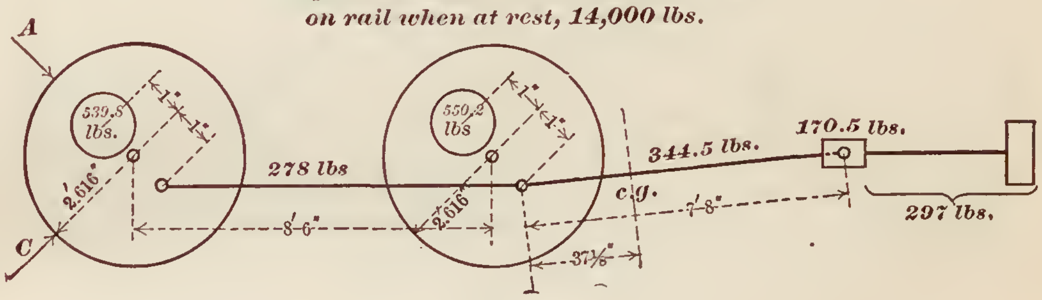


Fig. 3.

It was found by a comparison of reference marks, that distances along the length of the wires could be taken as representing equal distances around the face of the wheel. Thus, the length of each wire being greater than the circumference of the wheel, it would sometimes happen that a single wire would receive two impressions from the same reference mark; the distance between the two points thus impressed upon the wire was found to be equal to the circumference of the wheel. This fact made it easy to connect effects left upon a wire with the wheel positions (crank-angles) producing them.

Many of the wires that have been produced by the experiment described have since been carefully calipered at 5-in. intervals, the results plotted, and a smooth curve drawn through the points thus located. Some of the results thus obtained are presented as figs. 4, 5 and 6, the points representing the actual thickness of the wires being designated by means of small circles. It will be seen that all diagrams are plotted with reference to definite wheel positions.

THE BALANCE OF THE LOCOMOTIVE.

Before attempting a discussion of results in detail, it is necessary to consider somewhat briefly the condition of balance of the locomotive experimented upon. The engine as delivered by its builders was balanced for the road; but to increase its steadiness in the laboratory, weights were afterward added in equal amounts to the several wheels, until a *full horizontal balance* had been secured. The revolving and reciprocating parts which required counterbalancing, exclusive of the crank-pins and crank-pin bosses which are assumed to be parts of the wheels themselves, were found to weigh as follows:

Piston and piston rod	297.0 lbs.
Cross-head with part of indicator rigging attached	170.5 lbs.
Main rod	344.5 lbs.
Side rod	278.0 lbs.
Total for one side	1,090.0 lbs.

For complete horizontal balance, it was required that the sum of the weights making up the counterbalance of the two wheels on the side of the engine under consideration should be equivalent to 1,090.0 lbs. acting at a radius of 1 ft. To ascertain the distribution of balance between the wheels, it was necessary to examine them separately. Calculations based upon prints of the wheel centres gave the following results:

	Main Wheel.	Rear Wheel.
Balance cast in rim, and between the arms, plus the weights added at the laboratory, all reduced to equivalent weights acting at a radius of 12 in.	744.1	725.7
Weight of crank-pin and crank-pin hub to be subtracted	187.1	179.1
Net weights available to balance revolving and reciprocating parts acting upon the crank-pins	557.0	546.6

The sum of the net weights thus obtained for both wheels (1,103.6 lbs.) is 13.6 pounds greater than the sum of the actual weights to be balanced. But the engine is known to have been in perfect horizontal balance, the experimental methods adopted in securing this condition serving to indicate when the weights were changed even to the extent of a single pound. The calculated weight in each wheel is therefore assumed to be $\frac{13.6}{2} = 6.8$ lbs. heavier than the weights themselves, and this amount has been subtracted as a correction from the net weights given above, making the

	Main Wheel.	Rear Wheel.
Corrected net weight of counterbalance available to balance revolving and reciprocating parts acting upon the crank-pins	550.2	539.8

The weights of the parts involved, together with certain dimensions, are summarized in fig. 3.

Taking the weights of side rod and of main rod, as already given, and considering 0.6 of the weight of the latter as a revolving part,

	Main Wheel.	Rear Wheel.
The excess of balance over that required for revolving parts alone is	204.5	400.8

which shows 66 per cent. of the balance for reciprocating parts to be in the rear wheel.

Speed—58.3 miles per hour—312 revolutions per minute.

Scale *Length* *One division = 5"*. *Thickness* *One division = .01"*

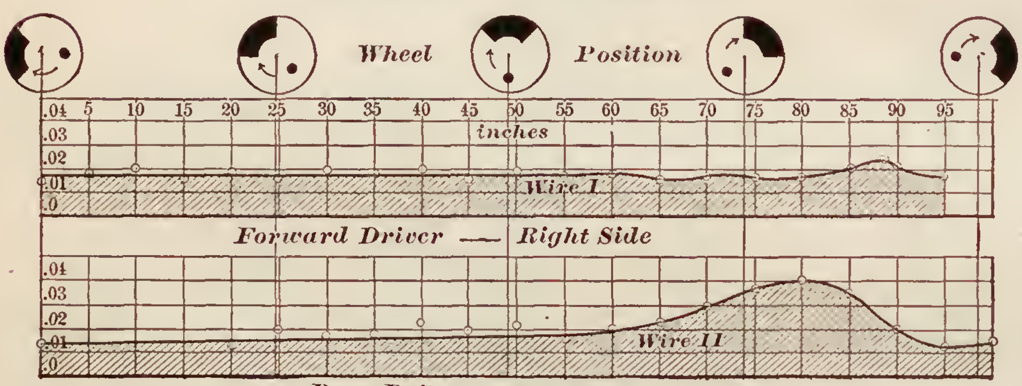


Fig. 4.

Six different rules for balancing locomotives for the road, reported as being in common use, give weights of counterbalance for the locomotive in question, as follows:

	Main Driver.	Rear Driver.
Rule A (for freight engines only)	467	260
" B (for all classes of service)	462	322
" C " " " " "	547	340
" D " " " " "	570	340
" E " " " " "	573	366
" F " " " " "	588	381
Average of five rules from B to F inclusive	548	350

Compared with these several standards, the weights of the counterbalances in the Purdue engine stand as follows:

	Main Wheel	Rear Wheel.
By Rule A (for freight service only),	17.8% too heavy,	107.6% too heavy.
" " B (for all classes of service),	19.1% " "	67.6% " "
" " C " " " " "	0.6% " "	56.9% " "
" " D " " " " "	3.5% too light,	56.9% " "
" " E " " " " "	4.0% " "	47.5% " "
" " F " " " " "	6.4% " "	41.6% " "
" the average of five rules from B to F inclusive	0.4% too heavy,	54.2% " "

It is evident, therefore, that the weight of the counterbalance in the rear wheel, from which most of the results about to be discussed were obtained, is in excess of that allowed by good practice as expressed by the rules already given. But practice cannot always conform to the law by which it assumes to be governed. It often happens where wheels are of small diameter, and the connections are heavy, as in mogul or consolidation engines, that there is not sufficient room in the main wheel to get in a counterbalance large enough for the revolving parts alone; in this case, therefore, the balance for reciprocating parts of this wheel must be taken by the other coupled wheels, in addition to that which, under the rules, would be counted as properly belonging to them. By this process, wheels having revolving parts which are rela-tively light are employed to balance a larger per cent. of all the reciprocating weights. Again, almost any eight-wheeled engine, balanced in an approved manner, will, if the coupling-rod is removed, have an excess of balance in the rear wheel equal to that for the engine under consideration; and such engines are not infrequently run while disconnected.

These considerations will serve to show that while the total weight of the counterbalances of the Purdue engine is, for reasons already stated, heavier than would be considered necessary for the road, and while at the time of the experiments the weights were not well distributed between the wheels, yet the conditions which existed are not at all rare. Doubtless many wheels are running which carry a greater counterbalance, when compared with the revolving weights to be balanced, than did the rear wheel of the Purdue locomotive.

RESULTS.

Attention has already been directed to the fact that in the engine experimented upon the excess of weight in the counterbalance over that required for the revolving parts alone was much greater for the rear driver than for the main driver. As the lifting effect is proportional to this excess of weight, it follows that wires run under the rear driver were likely to show more variation in thickness than those under the main driver. Results of experiments upon this point are shown by fig. 4, which represents wires obtained at the same instant from the main driver and the rear driver respectively. It will be seen that the wire (I) from the main driver shows but slight variation in thickness, notwithstanding the high speed (312 revolutions per minute), and it may be said that no wire was ever obtained from this wheel which gave evidence that the wheel had left the track. From mathematical considerations it can be shown that this wheel would not be expected to lift at speeds below 80 miles per hour (428 revolutions per minute), and such speeds are not practicable with wheels of the diameter experimented upon.

Passing now to an inspection of wire II (fig. 4), from the rear wheel, which was obtained at the same instant with wire I, it will be seen that there is a jump of the wheel just after the counterbalance has passed its highest point, which, when compared with the corresponding movement of the main driver, is very pronounced. Wires from this wheel at higher speeds are shown by fig. 5. In this figure the full

diameter of the wires is in each case shown by a dotted line drawn parallel with the base line. Wire III, made at 59 miles (316 revolutions), shows that there was an instant in the passage of the wire, corresponding to the point A, when it was barely touched by the wheel. Increasing the speed to 63 miles (337 revolutions) increased the lifting action of the wheel to the extent shown by wire IV (fig. 5). At the point B the wheel parted contact with this wire and did not again touch it until the point C was reached, an interval of about 40 in., the portion of the wire between B and C being entirely round and apparently unaffected by its passage under the wheel. A further increase of speed gives, as is shown by wire V, a

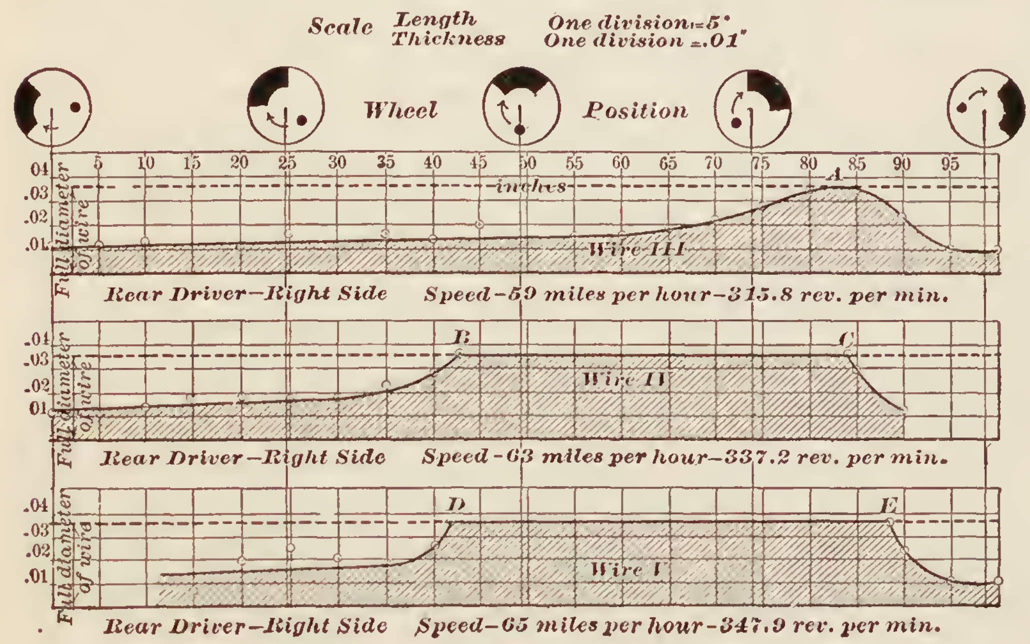


Fig. 5.

still greater length of full wire, the distance from D to E being very nearly equivalent to a quarter revolution of the driver.

It will be seen that all of these wires (II to V, figs. 4 and 5) substantially agree in showing the maximum lifting effect to occur after the counterbalance has passed its highest point, an effect undoubtedly due to the inertia of the mass to be moved; also in showing that the rise of the wheel from the track is more gradual than its descent. The latter condition follows as a sequence of the first.

Portions of the wires not shown on the diagrams do not vary much in thickness. The metal is rolled so thin by the normal pressure of the wheel that further increments of pressure do not greatly affect it. The wires, therefore, do not emphasize the destructive effect of the variation of wheel pressure when the change is insufficient to lift the wheel from the track.

It now remains to mention the effect of certain disturbing elements which are shown by the experiments to modify the actual movement of the wheel, other conditions remaining constant. For the rear wheel these disturbing elements are all in the nature of vibrations.

The first to be noticed is the rocking of the engine upon its springs, which motion tends to vary the pressure of the wheel upon the track independently of the action of the counterbalance. At one revolution the effect of the rocking may oppose the action of the counterbalance, and at the next revolution it may supplement the action of the counterbalance in producing a vertical movement of the driver. Again, the effect of the rocking may at a given instant be *nil*, and the wheel may rise under the action of the counterbalance; but in another instant the effect of the rocking appears, and the path of the wheel while in air is modified and its time of descent changed. Thus, the existence of this vibration makes it impossible to duplicate wires with certainty, even though the speed is constant; its effect is well shown by fig. 6. Wires VI and VII were taken from the rear drivers at the same instant, one from the right side, the other from the left; the speed, therefore, must have been the same for both. The right driver lacked a good deal of leaving its wire, but the left driver was in air for a tenth of a revolution. Again, wires VIII and IX were made in the same way at a higher speed; and here, while both drivers were off the track, the results are reversed, the right driver giving the greater length of full wire. It will also be seen from the diagrams, that not only is the extent of the vertical movement of the driver modified by the rocking of the engine, but the position of the wheel when such motion occurs is changed. It is evident, therefore, that this movement of the engine upon its springs will prove a serious difficulty whenever an attempt is made to predict as to the precise movement of the centre of gravity of the driver, whether the method of investigation be mathematical or experimental.

There appears, also, to be a vibration of parts, as, for example, of the wheel as a whole, these vibrations being of small amplitude. Evidence of the presence of such vibration is shown by the location of points on the diagrams of wires, figs. 4 to 6, which points represent the thickness of the wires as found by measurement. Referring especially to wires I and II (fig. 4), it will be seen that the actual thickness of the wire alternately increases and diminishes with every point. The time involved in passing from one high point to another (a distance of 10 in.) was about 0.01 of a second. This vibration may be traced on other diagrams; its amplitude is from two to four-thousandths of an inch only. Whether the process of introducing the wire starts, or has any connection with this vibration, the experiment does not show.

A third class of vibrations is made apparent by a duplication upon the wire of the reference mark on the wheel. As has already been stated, a light nick from a sharp chisel was made across the face of the wheel to serve as a reference mark. This nick leaves a clear-cut projection upon the wire. But at high speeds the single nick across the face of the wheel leaves two projections upon the wire, showing that after making one impression the surface of the wheel must for an instant have actually cleared the wire and then impressed itself a second time. The distance between these projections on the wires varies somewhat, but is usually about an eighth of an inch, which represents a time interval between the two impressions of about 0.008 of a second. The contact between wheel and track is therefore not continuous, but is a succession of exceedingly rapid impacts. These vibrations cannot affect the wheel as

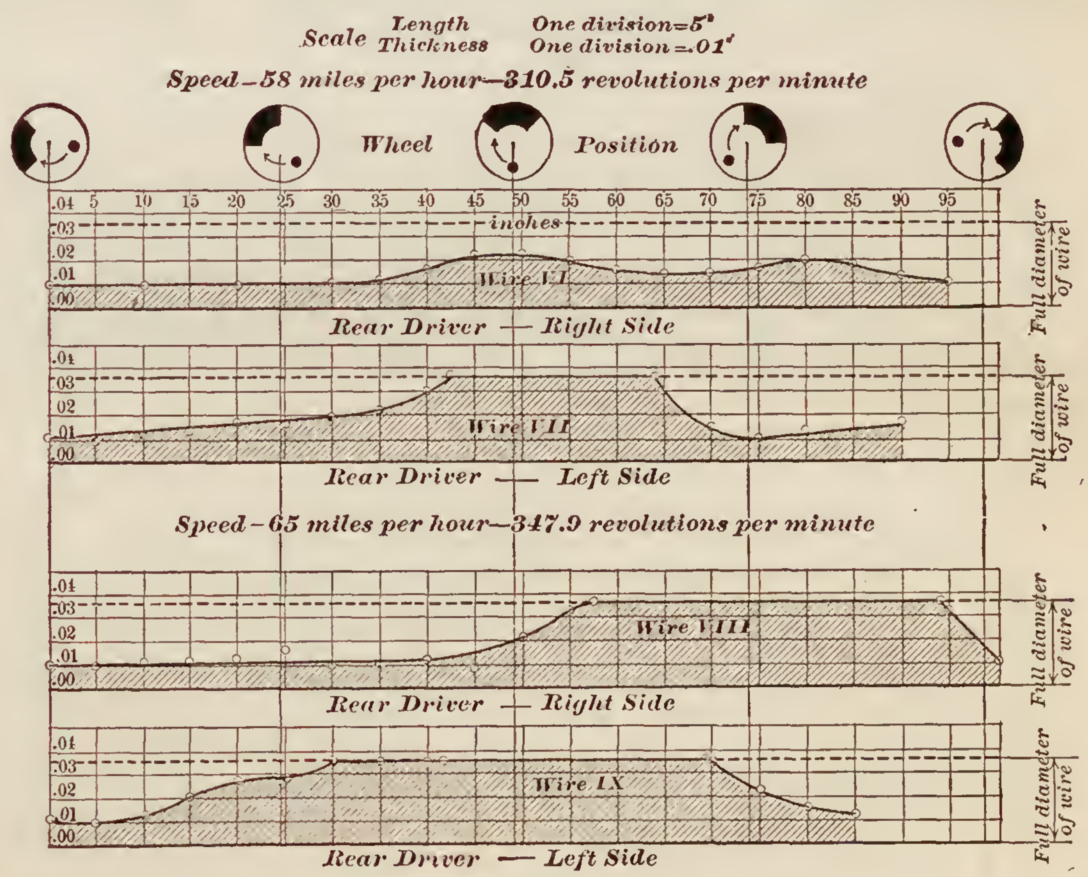


Fig. 6.

a whole; they are doubtless due to the elasticity of the materials, and involve only the parts immediately about the point of contact.

CONCLUSIONS.

The results of the experiments appear to justify the following conclusions:

1. Wheels balanced according to usual rules (which require all revolving parts, and from 40 per cent. to 80 per cent. of all reciprocating parts, to be balanced, the counterbalance for the reciprocating parts to be distributed equally among the several wheels connected) are not likely to leave the track through the action of the counterbalance, and cannot do so unless the speed is excessive.

2. A wheel which, when at rest, presses upon the rail with a force of 14,000 lbs., and which carries a counterbalance 400 lbs. in excess of that required for its revolving parts alone, may be expected to leave the track through the action of the counterbalance whenever its speed exceeds 310 revolutions per minute.

3. When a wheel is lifted, through the action of its counterbalance, its rise is comparatively slow and its descent rapid. The maximum lift occurs after the counterbalance has passed its highest point.

4. The rocking of the engine on its springs may assist or oppose the action of the counterbalance in lifting the wheel. It therefore constitutes serious obstacles in the way of any study of the precise movement of the wheel.

5. The contact of the moving wheel with the track is not continuous, even for those portions of the revolution where the pressure is greatest, but is a rapid succession of impacts.

The writer is indebted to Daniel Royse, M.M.E., junior member of the Society, for assistance in the preparation of data.

DISCUSSION.*

Mr. Forney: I regret very much that this important paper has come just before lunch, which is a time when it is difficult to get the attention of any considerable number of members. The paper is an extremely interesting one, and presents some matters which have been but very little understood and which are of very great importance in the operation of railroads. The fact that a locomotive driving-wheel in ordinary service actually rises entirely clear of the track at high speeds is a matter of so much importance that it certainly should receive great attention from the Society of Mechanical Engineers. There are some things in this paper, however, to which it seems to me that attention has hardly been sufficiently given. The paper indicates that the rising of the driving-wheel entirely clear of the track occurred only in those wheels which were practically overbalanced. The forward driving-wheel never rose clear of the track. It was only in the rear driving-wheel, which had a greater excess of balance than the forward one, that this action took place. On page 38 there are some figures given which present the results of six different rules for balancing the driving-wheels of locomotives. From the figures which are there given it will be seen that in every instance the wheels of this locomotive that were experimented with were overbalanced, as it is called. Now, I presume that there are hardly any of you here who have not at some time or other been to a country circus and seen a man get down on his hands and feet, and place a big stone on his stomach, and have somebody take a sledge hammer and break that stone to pieces without any injury to the man whatever. The fact is, that the stone resisted the inertia of the hammer to such an extent that it did not affect the man below it or his stomach. It seems to me that a somewhat analogous condition of things exists in a locomotive. Before the wheel can rise from the rail through the effect of the counterbalance, you must overcome the inertia of the weight of the wheel and axle, and driving-box and spring, and all the other parts which are not resisted by the elasticity of the springs. Now, before you can raise the wheel, that inertia must be overcome, and it is only what may be called the superfluous effect of the action of the counterbalance which has any effect in raising the wheel from the track. It is for this reason that it is only when the wheel is overbalanced that this effect takes place. For that reason, as practical question, it does not seem to me to be of so much importance as it would appear from the paper before us. As I said, it is before lunch, and probably the audience is not disposed to listen to any more discussion.

The President: We do not want to cut off the discussion on that account. Those who want lunch can go and get it. The others can remain.

Mr. Morison: I was going to ask Mr. Forney a question. He has shown us a man lying on his back with a big stone on his stomach, and another man—with a light hammer presumably—striking very rapid blows, breaks that stone. Supposing that man, instead of taking a light hammer and striking rapid blows, had taken a heavy hammer and struck a slow blow and broken the stone, what would have been the effect on the man under the stone?

Mr. Forney: My reply to that would be similar to what Mr. Stephenson said about the cow on the railroad track—it would have been bad for the man.

The President: I want to call the attention of the Society to the fact that a paper will be read on Friday on Rail Pressures of Locomotive Driving-Wheels.

Mr. Morison: I am very glad that the matter is coming up in that form again. But it seems to me that the case of the counterbalancing of locomotive driving-wheels resembles the case which is bad for the man rather than the case which is good for the man—that it corresponds to a slow blow struck with a heavy hammer much more than it corresponds to a quick blow struck with a light hammer; but when you have a driving-wheel lifted from the track by the motion of a revolving counterbalance, you have simply an exaggerated form of what exists when it is not lifted from the track. There is a blow which gives superficial notice of what is occurring, and has in quite a number of instances bent rails so that they have had to be moved from the track, which occurs only when the wheel is lifted from the track. But assuming that you have a driving-wheel with 14,000 lbs. weight upon it counterbalanced in such a way that running at a given speed that wheel is actually lifted from the track; if you have the same wheel with 15,000 lbs. on it counterbalanced in the same way, you would have the effect of a wheel when running at the given speed, in which the pressure of the wheel varied from 1,000 lbs. to 29,000 lbs., instead of being, as is assumed in most calculations for rails and bridges and other such things, a uniform pressure of 15,000 lbs. It seems to me that that is a variation which is of enormous importance; that there is nothing now from which our permanent structures, our rails, our bridges, and everything else on railroads, our ties and all, are suffering much more than from this simple cause, and that there is nothing which, with the high speeds we are now running our trains on, it is more important to eliminate. That is the way it impresses me, that we are having a constant variation of pressure in a position where it is of the utmost importance to secure uniform pressure, uniform wear, and every other uniform result.

Professor Webb: I should like to call Mr. Forney's attention, if he has not noticed it, to the remark on page 38, "that at 80 miles an hour this wheel would be expected to lift, and that, owing to this locomotive not being constructed so as to run at those speeds, they did not get that wheel to lift." And then I would also remark further that perhaps undue attention is attracted by the fact of the wheel lifting. When it does not actually lift from the track, it strikes a blow not so great, but still it strikes a blow. If the truck would be depressed, say one-tenth of an inch, with a dead weight, and then the vibration come so that it nearly lifts from the track, you will get quite a blow then, and these vibrations go on accumulating. They are not regular; and where at first it might not lift, it might afterward lift from the rail. Then the variation of the pressure might reduce the traction so the wheel tends to lift. Of course the momentum would not allow it to slip much. But it would slip some.

Mr. Strong: I do not think that there are very many railway managers who would consent to have an engine delivered to them that had 30,000 lbs. on the wheel. I remember several years ago I built for the Lehigh Valley an engine, and because the engine weighed 3,000 lbs. more than any other engine on the road, and had 17,500 lbs. to the wheel, while other engines had in the neighborhood of 17,000 lbs., they would not allow the engine to run over the road until they had strengthened some of the bridges. And then, again, a short time afterward we built another engine that had 90,000 lbs. on six wheels, and the General Superintendent would not allow the engine to run over the main division, where it was intended to run, for 6 months, until they had strengthened up a number of bridges because there was 90,000 lbs. on six wheels. There is no doubt in my mind that they had dozens of engines on that division all the time that were putting as high as 30,000 lbs. pressure on the rails right over the bridges. That is a question that is coming up all the time—the question of how much will you allow on a wheel—and yet at the same time they have got double the load on the wheels all the time and do not know it.

Now, as to the question of balancing these reciprocating parts: you take the different locomotive builders; one man will say, balance all the reciprocating parts. Another will say, balance half the reciprocating parts. A few years ago I built an engine in Boston, and we balanced two-thirds of the reciprocating parts. We got the engine out and ran it on the

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Shore Line to break it in; and although the engine and tender weighed 100 tons when we ran it without a train on it up to 60 miles an hour, the engine would move so that it would jog the seat under me, showing that the unbalanced third of the reciprocating part was changing the direction of 100 tons at least 350 times a minute. We ran that run on a train for a week or so, and the Superintendent sent out an expert to find out why the baggage wouldn't stay piled up in the baggage-car, and the expert came back and said it was the fault of the springs in the baggage-car. I knew what the trouble was, and so did the Master Mechanic. We took the engine in and put 450 lbs. of lead and antimony into the wheels, so that we balanced them fully up to the weight of the reciprocating parts. After that there was no trouble. Yet when you got the engine up to a speed of 90 miles an hour and put your hat rim on the window pane you could feel the whole engine trembling like a leaf with the terrific force that was disintegrating the whole machine. The bolts that held the cylinders on to the boiler were sheared. The guides were broken loose from the cylinders. And after running the engine for three months at those high speeds we spent nearly $1,500 in putting the engine in repair again, while we had run the engine on another road for 6 or 9 months before where we did not get up those high speeds, and did not have any repairs at all. I have not any doubt that fully one-third of the general repairs to a locomotive are due to the unbalanced parts of the engine, and I have no doubt that fully one third of the wear and tear of the track is due to the same cause.

On the Reading Road a few years ago they had a lot of engines with very heavy reciprocating and revolving parts. One of those engines, at a speed of about 70 miles an hour, bent 3 miles of track, 76-lb. rails, so that they had to take the rails out and throw them away in the scrap heap until they could be straightened, and they sent them to Bethlehem to straighten, and put them in sidings. It left the mark of the flange on the top of the rail. In some places where the wheel came on top of the rail the engine left the track and ran nearly 100 yds. over the ties. Only a short time ago I saw on the North Pennsylvania branch a new piece of track which had only been down 3 years, and I walked about 3 miles and counted in that distance between thirty and forty 80-lb. rails that had kinks that were distinct, some as large as 2 in. in the length of the rail. The rails had to be taken up.

Mr. Dean: This matter of balancing locomotive driving-wheels and reciprocating parts I think is of fully as much importance as Mr. Strong has represented, and also Mr. Morrison. In my own experience in riding on locomotives I have noticed a great deal of vertical vibration, which could only be accounted for, so far as I was able to account for it, by supposing that the wheels actually left the rails. The engine to which I refer developed that maximum effect at a speed of almost exactly 60 miles per hour. Below that speed it was hardly perceptible, and above it it was hardly perceptible. But the speed of 60 miles an hour was frequently maintained for a long period, in relation to the length of the road, but not very long in time. There are places, of course, where a speed of 60 miles per hour or any other speed is maintained for a mile or two, and of course if it were maintained for only 2 miles, and had this effect on the engine, either in loosening the bolts or in general disintegration, it can still be considered of vital importance to the life of the whole plant of the system. I think that it is a matter to be regretted that the mechanical departments of most of our railroads are not upon a higher plane. I make all the exceptions that everybody knows ought to be made. There are many roads that are conducted intelligently in the mechanical department. The majority of them are not. This matter, I think, is something which is growing in importance, at least growing upon the attention of the people, and it is bound sooner or later to bring about the balancing of locomotives. Mr. Strong has made studies in this matter, and without doubt has a design which will overcome this difficulty perfectly, as it can be overcome, and that is to say really, perfectly.

Now, to return to the class of locomotives to which I refer in which this effect was apparent, the vertical vibration was very unpleasant to a person upon the seat in the cab; and it was inconceivable to me that it could be produced except by the wheels actually leaving the rail. I do not know that I had ever heard at that time that anybody knew that a wheel ever did leave the rail; but Professor Goss has amply shown that it does, and it would seem that these indentations that Mr. Strong has seen on the rail are additional proof. I hope that something will be done in this matter in the future.

Professor Lanza: Referring to this matter of balancing locomotives, it seems to me that we have generally assumed, on the one hand, that we have got to balance the horizontal throw. Of course we hear a great deal about this hammer-blow question. In an ordinary locomotive you cannot balance both the horizontal and the vertical. You have got to make a compromise. The question is, Where is the compromise coming? I should like to ask whether any railroad man has ever tried balancing the vertical and letting the horizontal go, and what happened. I am not recommending this, but I would like simply to know if it has ever been tried, with a view of seeing how much of the horizontal you had better balance any way.

Mr. Porter: With respect to the cranks themselves and the side-rods and the crank end of the connecting-rod, the vertical stresses of these parts, and of the counter weights equal in weight to these parts, and are equal and opposite at any speed whatever, and so there is no variation in the pressure on the rail. The piston, the cross-head, the piston-rod and the cross-head end of the crank-rod are parts which have only a horizontal motion, and which needs to be balanced. I apprehend that in the perfect locomotive some way can be found for balancing this portion of the reciprocating parts of the engine other than by a revolving mass which has a vertical component which cannot be balanced. Then it makes no matter how heavy the cranks are, how heavy the side-rods are, how heavy the crank end of the connecting-rod is, because the counter weight, equal in weight to them, will have a vertical stress equal and opposite to theirs always. But I really think that absolute steadiness of motion, with uniform pressure on the rails, can only be obtained by balancing the reciprocating parts in some other way than by a revolving mass.

Mr. Forney: I would say to Mr. Porter that Mr. Strong has been engaged in designing an engine in which he hopes to accomplish that; and I have been engaged in designing one in which I hope to accomplish the same thing. We therefore occupy the same attitude in relation to the questions under discussion.

With reference to what Mr. Morrison said, I will illustrate my point a little further. If you will take his ideal strong man and his ideal heavy sledge, and let that man strike a blow with all his force directly on the rail, it is quite conceivable that the man might break the rail. But suppose, instead of striking directly on the rail, you were to take a pair of driving-wheels on an axle with driving-boxes and eccentrics on it, and allow that man to strike on the top of the driving-wheel; evidently the effect on the rail would be less than if he struck the rail directly. In the one case, the blow of the sledge must overcome the entire inertia of the wheel before it affects the rail at all, when the motion of the locomotive is very rapid, and there must be sufficient time for the entire centrifugal force to act against the inertia of the wheel and affect the rail. If you will refer to the paper, at page 38, the last line of the last table, you will see there five rules, B to F inclusive; you will see that the main wheel was counterbalanced 4 per cent. too heavy, and the rear wheel was counterbalanced 54 per cent. too heavy. Now, if you will refer back to fig. 4 you will see that in the first diagram, with wire 1, that the wheel which had an excess of 4 per cent. of counterbalance had very little effect on the wire. If you come now to the second wire in the diagram below that, it was acted upon by the rear wheel, which was counterbalanced 54 per cent. too heavy, you can see there that the driving-wheel lifted clear off the rail. In other words, an excess of 54 per cent. of counterbalance produced the effect of lifting the wheel clear off of the rail, while an excess of 4 per cent. did not have that effect. So that it is a fair inference that the great evils presented here are due to over-counterbalancing. Now, I am not arguing that having this disturbing effect and this tendency is a good thing—not by any means. But do not let us delude ourselves into the belief that the injurious effects are greater than they really are.

Mr. McGeorge: I would like to give one instance to show the effect of the vertical counterbalance. The question is, What are we to counterbalance—the horizontal moving parts or the vertical moving parts? I have in my mind an instance of a rolling-mill engine which was very heavily loaded and running very fast. That engine had to have the brick-work repeatedly repaired. The excess of counterbalance, as Mr. Forney puts it, was exercised, I suppose, vertically, and crushed the brick-work from the front end, and the makers of the engine had to put an excess of bearing surface under the engine to stop that result. I just cite this to show the evil influence of what Mr. Forney, I suppose, is referring to as overbalancing. It is certainly overbalanced vertically, but not overbalanced horizontally. Now the question is, Where will you compromise?

Mr. Morison: Mr. Forney is undoubtedly correct in stating that it takes some time to get the full effects of any variation in weight or pressure; but I think he is entirely wrong in as-

LOCOMOTIVE RETURNS FOR THE MONTH OF SEPTEMBER, 1894.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage. Passenger Trains.	Locomotive Mileage. Freight Trains.	Locomotive Mileage. Service and Switching.	Locomotive Mileage. Total.	Locomotive Mileage. Average per Engine.	Av. Train. Passenger Cars.	Av. Train. Freight Cars.	Coal Burned per Mile. Passenger Train Mile.	Coal Burned per Mile. Freight Train Mile.	Coal Burned per Mile. Service and Switching Mile.	Coal Burned per Mile. Train Mile, all Service.	Coal Burned per Mile. Passenger Car Mile.	Coal Burned per Mile. Freight Car Mile.	Cost per Locomotive Mile. Repairs.	Cost per Locomotive Mile. Fuel.	Cost per Locomotive Mile. Oil, Tallow and Waste.	Cost per Locomotive Mile. Other Accounts.	Cost per Locomotive Mile. Engineers and Firemen.	Cost per Locomotive Mile. Wiping, etc.	Cost per Locomotive Mile. Total.	Cost per Car Mile. Passenger.	Cost per Car Mile. Freight.	Cost of Coal per Ton.
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Atchison, Topeka & Santa Fé	864	784	....	....	....	1,819,945	2,528	....	....	....	....	....	83.60	....	....	4.38	7.44	0.44	....	6.76	1.55	20.57	....	....	1.76
Canadian Pacific	609	....	481,124	720,718	393,820	1,595,662	2,620	....	....	....	....	....	68.77	....	....	2.76	9.99	0.29	....	5.73	1.12	19.89	....	....	2.92
Chic., Burlington & Quincy	....	541	....	....	....	1,391,160	2,570	5.38	21.40	....	....	....	83.44	....	....	3.07	5.34	0.20	0.14	6.96	....	15.71	....	....	1.30
Chic., Milwaukee & St. Paul	....	853	....	....	....	2,478,390	2,919	....	....	....	....	....	....	....	....	3.53	6.76	0.25	....	6.84	....	17.38	....	....	2.15
Chic., Rock Island & Pacific	....	564	466,694	890,412	284,189	1,641,295	2,892	....	....	....	....	....	68.73	....	....	2.83	6.03	0.21	1.17	1.66	....	11.90	....	....	2.04
Chicago & Northwestern	....	1010	780,135	1,442,488	710,891	2,933,414	1,624	....	....	....	....	....	82.98	....	....	3.29	8.35	0.27	....	6.32	0.80	19.07	....	....	2.00
Cincinnati Southern	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Cumberland & Penn.*	....	....	5,361	37,148	....	42,509	....	....	....	....	....	....	71.44	....	....	5.33	4.08	0.33	....	....	1.63	11.37	....	....	....
Delaware, Lackawanna & W. Main L	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Morris & Essex Division	....	162	178,587	140,652	88,430	407,669	2,522	....	....	....	....	....	68.34	....	....	4.42	10.52	0.38	....	7.32	....	22.64	....	....	3.08
Flint & Père Marquette	....	82	85,120	65,512	51,263	201,895	2,462	....	....	45.98	79.98	64.21	61.68	....	....	2.95	5.88	0.12	0.02	5.07	0.99	15.03	....	....	1.81
Hannibal & St. Joseph	....	69	64,819	137,229	33,157	235,203	2,482	5.05	17.13	....	....	....	78.71	12.83	6.17	1.74	4.93	0.14	0.14	6.50	....	13.44	....	....	1.32
Kansas City, Ft. S. & Memphis	....	132	93.935	146,103	73,260	313,298	2,700	....	....	....	....	....	62.65	....	....	3.32	4.64	0.35	0.46	7.44	....	16.21	....	....	1.42
Kan. City, Mem. & Birm	42	39	32,280	47,186	15,286	94,752	2,430	....	....	....	....	....	65.25	....	....	3.68	3.01	0.34	0.29	6.75	....	14.07	....	....	0.92
Kan. City, St. Jo. & Council Bluffs	....	37	46,514	36,110	39,199	121,823	3.384	5.03	20.99	....	....	....	70.16	13.90	4.66	2.95	5.95	0.20	0.48	6.61	....	16.19	....	....	1.89
Lake Shore & Mich. Southern	....	591	360,711	694,328	423,644	1,478,683	2,502	....	....	....	....	....	64.43	....	....	2.71	4.81	0.11	....	....	0.13	7.76	....	....	1.49
Louisville & Nashville	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Manhattan Elevated	....	279	686,929	....	61,387	748,316	2,649	....	....	....	....	....	35.70	....	....	2.00	2.10	0.70	....	9.50	....	19.30	....	....	4.04
Mexican Central	148	130	....	....	....	405,722	3,121	....	....	....	....	....	63.80	....	....	4.22	12.23	0.38	0.12	4.95	....	21.90	....	....	3.87
Minn., St. Paul & Sault Ste. Marie	104	79	97,348	147,869	31,766	276,983	3,506	4.24	18.91	....	....	....	62.88	....	4.65	2.61	7.64	0.22	....	6.31	....	16.78	3.66	1.05	2.41
Missouri Pacific	....	351	....	....	....	908,940	3,101	4.37	17.56	....	....	....	75.13	13.73	5.65	4.47	5.62	0.32	1.57	6.40	1.36	19.74	3.58	1.35	1.45
Mobile & Ohio	105	80	73,543	125,582	51,808	250,933	3,137	....	....	....	....	....	62.61	....	....	3.40	3.99	0.20	0.66	5.68	1.02	14.95	....	....	1.28
N. O. and Northeastern	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
N. Y., Lake Erie & Western	....	629	437,346	730,884	239,784	1,408,014	2,238	4.80	24.80	....	....	....	95.25	18.60	5.30	4.22	7.36	0.33	1.70	7.41	1.24	22.26	....	....	1.38
N. Y., N. H. & H., Old Colony Div	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
N. Y., Pennsylvania & Ohio	....	277	129,582	367,921	149,571	647,074	2,335	6.00	19.70	....	....	....	89.45	11.70	6.20	3.30	6.10	0.30	1.99	7.08	1.06	19.83	....	....	1.18
Norfolk & Western, Gen. East. Div.†	....	....	95,859	314,478	51,625	461,962	2,800	5.50	20.90	44.31	111.49	....	77.90	8.32	5.32	6 77	3.29	0.28	....	....	....	10.34	....	....	....
General Western Division†	....	....	104,638	357,479	57,593	519,710	2,638	5.33	17.75	70.00	127.00	68.00	118.00	13.09	7.85	8.21	3.94	0.24	....	....	....	12.39	....	....	....
Ohio and Mississippi	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Philadelphia & Reading	....	....	440,560	317,826	828,907	1,577,293	....	....	....	....	....	....	79.09	....	....	4.37	3.95	0.19	....	5.77	0.43	14.71	....	....	....
Southern Pacific, Pacific System	723	643	614,379	992,767	273,403	1,180,649	2,925	5.37	14.30	....	....	....	69.39	....	....	5.43	16.71	0.18	2.24	7.38	1.11	33.05	....	....	4.83
Union Pacific	698	....	869,194	403,234	258,238	1,530,666	3,533	6.25	20.85	....	....	....	101.88	....	....	6.57	8.76	0.40	0.87	7.73	1.04	25.37	3.83	1.48	1.71
Wabash	417	324	413,444	584,812	211,185	1,210,441	3,736	4.75	19.32	28.77	18.63	36.51	85.54	14.10	6.31	3.69	5.19	0.32	....	5.65	....	15.69	....	....	1.21
Wisconsin Central	149	110	136,283	177,595	80,284	394,162	3,583	....	....	....	....	....	75.87	....	....	2.15	6.70	0.17	....	7.02	....	16.04	....	....	1.94

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars. Empty cars which are reckoned as one loaded car are not given upon all of the official reports, from which the above table is compiled. The Union and Southern Pacific, and New York, New Haven & Hartford rate two empties as one loaded; the Kansas City, St. Joseph & Council Bluffs, and Hannibal & St. Joseph Railroads rate three empties as two loaded; and the Missouri Pacific and the Wabash Railroads rate five empties as three loaded, so the average may be taken as practically two empties to one loaded.

* Switching engines allowed 6 miles per hour; wood, construction and gravel trains, 10 miles per hour.

† Wages of engineers and firemen not included in cost.

suming that the blow is at the top of the driving-wheel. The blow is struck by the driving-wheel itself, and is struck on the rail at the bottom of the driving-wheel, where the driving-wheel is in contact with the rail. I think there is no doubt that it does take time to distribute that effect over the rail and so over the roadbed, and that that is in a measure a relief to the rail and of the apparent immediate effects, but I think that the effect comes there just as much. There is a varying pressure which is a source of constant wear, and a source of constant strain on the whole engine, because not only does it make a vertical disturbance, but it makes a constant difference in the adhesion. Furthermore, I think there is no doubt that some pretty serious accidents which have never been explained have really been due to this cause. Any one who has had any thing to do with a railroad over an undulating country knows how trains run at the foot of grades, knows that often a heavy freight train at the foot of a grade is running just as fast as it can go to get momentum to take it up the grade beyond. Almost all bent rails have been found right down between two hills. I am inclined to think that it has been rather fortunate that wheels have occasionally left rails and left their visible marks, for this has opened our eyes to one of the risks we are running.

Mr. Oberlin Smith: I think that Mr. Morison is right in saying that the blow, as it is called, is struck by the wheel itself rather than anything else.

Mr. Forney: Will you allow me to ask a question? Take a pulley which is not balanced—does that pulley produce a blow?

Mr. Smith: No, sir.

Mr. Forney: Now, if you put a balance in it, does it produce a blow? Which produces the blow, the balance or the wheel?

Mr. Smith: I am coming to that. I was just going to remark that there is not any blow there. There is not any hammer blow about it. A hammer blow is the sudden striking of something or another with something else which has a lot of momentum. Now, in a locomotive wheel it is purely an undulating pressure. We start at the point of balance with no pressure on the rail, with the part of the weight of the locomotive that is on the wheel, and the centrifugal force of the unbalanced parts tries to throw the wheel one way, and we have a tendency to make a depression in the rail gradually and produce waves in those rails. But as to there being any blow there, I do not see where it is.

Mr. Strong: I want to describe the action of the engine on this track which I examined on the North Pennsylvania Road. These badly bent rails were at the foot of the grades, as Mr. Morison says, and on a curve. Now, the locomotive, being coupled upon the quarters, of course the variation comes alternately on one side and then on the other. The result of it is, the lifting on one side and then on the other side puts the engine into a rolling motion; and when you get up to the point where the wheel actually leaves the rail, the wheel comes up and then goes down in such a way as to strike the rail and bend it in. All these are down, and in some places as much as $\frac{1}{2}$ in., perhaps 2 in. down—not in the whole length of the rail, but it would be between two ties. It is a regular kink. It is not a long and easy curve, but it is a distinct bend, almost as distinct as if the driving-wheel was let down into it. In every case the rail is bent in two directions, down and in, in every case—never out—showing that the engine gets this rolling motion and the wheels strike a blow as they come down and in in that way.

Professor Webb: I think you can see that it is the wheel that strikes the blow, that it is the wheel that is really the hammer, by remembering the law of mechanics, that any circular body, we will say, whose centre of gravity is not in the centre of the circle, if placed free in the air, will revolve about the centre of gravity and not about the centre of the circle. Now, in this case, if I am right, this counterbalance shows the centre of gravity of the wheel at about $\frac{1}{10}$ in., we will say, and therefore that wheel is trying to revolve about this point. Now, in order for the rail to accommodate that, it would have to spring out of the way that much. We are, therefore, running an eccentric wheel on the track, and you may call it a hammer blow or anything that you please. If the thing runs smoothly, the track has got to get out of the way, and the track refusing to do that is what makes the danger. If the track does not get out of the way, the centre of the wheel has got to rise and fall five times a second through $\frac{1}{10}$ in., or twice that. Consequently that is the same as if the wheel were a hammer.

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

The object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publications will in time indicate some of the causes of accidents of this kind, and to help lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with the information which will help make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a great favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in November, has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS IN NOVEMBER.

Foster, Pa., November 1.—A collision occurred at this place this morning between a coal train and an express train, in which Engineer James Lynott and Firemen William Hoscy and Elmer Scull were killed. The accident was caused by a mistake on the part of the head brakeman of the coal train throwing the wrong switch and sending the engine across the main line on which the express was running. The express engine glanced off and ran up a bank 15 ft. high before it stopped. It was a gradual rise, and the ground was soft, so that the train stopped without any perceptible concussion and with no injury to any of the passengers. The engine then tipped over, crushing the fireman, but the engineer escaped without a scratch, although he stuck to his post to the end.

Galveston, Tex., November 2.—A collision took place between a passenger and a work train on the Houston & Texas Central Railroad at Manor to-night. An engineer and fireman were hurt about the neck and back.

New Orleans, La., November 4.—A switching engine on the Texas & Pacific Railroad was derailed in the yards here this morning and turned over. Charles Burmeister, the engineer, was caught beneath the locomotive and had his legs crushed in a terrible manner. He died from the effects of his injuries.

St. Louis, Mo., November 6.—William Wilson, an engineer employed by the Terminal Association, was crushed to death this evening by being caught between his engine and tender and a train moving on the next track.

Pittsburgh, Pa., November 7.—A collision occurred on the Baltimore & Ohio Railroad at Rosensteel Siding, east of here, to-night. The collision occurred between a passenger and a freight train, and both engineers and both firemen were killed.

Rockford, Ill., November 9.—As a freight train on the Chicago & Great Western Railroad was passing over a bridge at this point to-day that is being rebuilt, the structure gave way and the tender with 10 cars went down. The fireman was slightly injured.

Chicago, Ill., November 11.—An excursion train on the Wisconsin Central Railroad was thrown from the track at Crawford Street this afternoon by a misplaced switch. Patrick Lahey, the engineer, had his arm wrenched in jumping from the train, and the fireman, Walter Charlton, had his arm and side lacerated.

Temple, Tex., November 12.—A collision occurred on the Atchison, Topeka & Santa Fé Railroad at Crawford this morning between a passenger and a freight train, in which Engineer Crane of the freight train sustained a dislocation of his shoulder and a severe contusion on the chest. Engineer Fleming was also considerably bruised.

Nashua, N. H., November 15.—The boiler of a locomotive on the Concord & Montreal Railroad exploded half a mile from this city to-day. Fireman Bean was badly scalded by the escaping steam. The engine was just out of the shop, and on its trial trip.

Pittsburgh, Pa., November 15.—A rear-end collision occurred on the Pennsylvania Railroad at Irwin this afternoon. Engineer John Davidson and Fireman Coulter were slightly injured.

Bagley Junction, Wis., November 16.—Two engines on the Wisconsin & Michigan Railroad collided near here to-day. One engineer was slightly injured.

Massillon, O., November 17.—A switching engine and a coal train on the Cleveland, Lorain & Wheeling Railway collided at the Warmington switch to-day. Engineer Rosenberry, of the coal train, was killed outright and his fireman was fatally injured.

Eunice, Ark., November 17.—A successful attempt at train wrecking was perpetrated here to-night on the Missouri Pacific Railroad, in which the engine was overturned. Fireman Gerger was killed and Engineer Mauldin fatally injured.

Philadelphia, Pa., November 17.—A collision occurred between two shifting engines on the Pennsylvania Railroad on what is known as the Junction Road, below the Spring Garden Street bridge. Eugene Victor, one of the engineers, was slightly injured about the head and body.

Memphis, Tenn., November 18.—Shortly after midnight this morning an attempt was made by train robbers to hold up a train on the Yazoo & Mississippi Valley Railroad at Panther Run, Miss. A red light was displayed, but it was disregarded by the engineer. Thereupon the robbers fired a volley into the cab, wounding Fireman Cole, who received a bullet through his arm.

Tunkhannock, Pa., November 18.—Through the mistake of a flagman, two freight trains on the Lehigh Valley Railroad collided at Hamet's Ferry this morning. Engineer Freeman, of the westbound train, was badly injured, and his fireman, George Smith, had a leg broken while jumping from the engine.

Frazer, Tenn., November 19.—A freight train on the Chesapeake & Ohio Southwestern Railroad was wrecked here to-day by a misplaced switch that had been thrown in order to rob a passenger train. Fireman Thomas Matthews was killed and Engineer Lloyd Grimes was so badly injured that his recovery is doubtful.

Albany, N. Y., November 20.—A misplaced switch caused a collision between a Belt Line train and an express on the Delaware & Hudson Canal Company's Railroad at Livingston Avenue this afternoon. Fireman Graham, of the express train, sprained his ankle in jumping from the engine.

Chicago, Ill., November 20.—J. M. Griffin, an engineer on the Lake Shore & Michigan Southern Railroad, was fatally injured in a wreck that occurred in the yards here to-day.

Worcester, Mass., November 21.—Two passenger trains on the New York & New England Railroad had a collision on the main track about a quarter of a mile from Oxford Station at five o'clock this afternoon. The accident was caused by a misplaced switch. Thomas F. Curran, a fireman, had his arm and shoulder bruised and ankle sprained; Engineer Charles G. Davis sustained severe scalp wounds, and Engineer Albert A. Walker had his hip bruised and back wrenched.

Chicago, Ill., November 21.—A cylinder-head on a locomotive on the Alley Elevated Railroad blew out to-day. William Ulrich, the fireman, jumped to the ground, a distance of 30 ft., and broke his leg.

White Plains, N. Y., November 22.—A locomotive hauling an express train on the Harlem Railroad jumped the track near Unionville this afternoon. The locomotive finally turned over, and Engineer Delos Franklyn, who stuck to his post, was badly but not seriously bruised about the body. Fireman John Brady jumped and was severely cut.

Toledo, O., November 24.—Henry Mack, an engineer on the Wheeling & Lake Erie Railway, was stricken with paralysis this evening and fell out of his cab window. His skull was fractured, and he died shortly afterward.

Salt Lake, Utah, November 24.—A passenger train on the Union Pacific Railway was derailed near Sandy this afternoon. Although the engine plunged over a 5-ft. embankment, the engineer escaped uninjured, and the fireman was knocked senseless but was not seriously hurt.

Raleigh, N. C., November 26.—Alexander Clark, an engineer on the Seaboard Air Line, became frightened on seeing a locomotive headlight in front of him on entering this city to-night. Calling to his fireman to jump, he set the example and broke his neck and had his head crushed.

Pittsburgh, Pa., November 27.—William Welshons, an engineer on the Pennsylvania Railroad, was struck by a passing train and killed at Roup Station this morning. He was the engineer that took the first train out of the Union Station after the great railroad riots of 1877.

Buffalo, N. Y., November 28.—A misplaced switch caused the wrecking of a freight train on the Buffalo, Rochester & Pittsburgh Railroad at Springville this morning. Barton Leonard, one of the engineers, was instantly killed.

Hallville, Tex., November 28.—Some one placed some spikes on the rails in front of a passenger train on the Texas & Pacific Railroad this afternoon, causing its derailment. Fireman R. Stephenson was thrown to the ground and the knee-cap of his left leg was crushed in; he was also otherwise injured.

Hartford, Conn., November 29.—M. J. Lewis, an engineer on the New York & New England Railroad, was killed in a collision to-day between his engine and a passenger train of the Consolidated Railroad at a crossing of the two roads.

St. Paul, Minn., November 30.—A head-end collision occurred on the Northern Pacific Railroad between a light engine and a stock train. Engineer Anderson had his left foot caught and badly injured.

Palestine, Tex., November 30.—In a freight wreck 40 miles west of here, on the International and Great Northern Railroad, Engineer Wardlow and Fireman Schubert were so dangerously injured that they are not expected to live.

Our report for November, it will be seen, includes 31 accidents, in which 15 engineers and 8 firemen were killed, and 11 engineers and 13 firemen were injured. The causes of the accidents may be classified as follows:

Boiler explosion	1
Caught between trains	1
Collapsed bridge	1
Collisions	13
Cylinder-head blowing out	1
Derailments	3
Falling from engine	1
Jumping from engine	1
Misplaced switches	2
Run over	1
Train robbers	1
Train wreckers	3
Unknown	2
Total	31

PROCEEDINGS OF SOCIETIES.

Association of Engineers of Virginia.—At the November meeting Mr. H. A. Gillis read a paper giving the different processes of manufacturing steel both now and in earlier days, and showing the different qualities due to the presence of different quantities of carbon, manganese, silicon, sulphur, phosphorus, etc., in its composition.

Engineers' Club of St. Louis.—The Secretary reports that a serious typographical error crept into his last report regarding the price paid by the city of St. Louis to the St. Louis Sanitary Company for the reduction of garbage; it is 9 cents per 100 lbs. instead of per pound, and no payment is made for quantities above 100 tons instead of 200 tons, as stated.

The American Society of Mechanical Engineers.—The annual meeting was held at the house of the society in New York from the 3d to the 7th of December. The following is the list of papers that were presented: Relative Tests of Cast Iron, by W. J. Keep. Notes on Steel Forgings, by George M. Sinclair. Trials of a Vertical Triple-Expansion Condensing Pumping Engine at the Trenton Water Works, by Samuel and S. S. Webber. Tests on the Triple-Expansion Engine at the Massachusetts Institute of Technology (second paper), by Peabody-Miller. Trial of a Leavitt Pumping Engine; Trials of a Recent Compound Engine with a Cylinder Ratio of 7 : 1; Changing the Suction System of a Pumping Engine, by F. W. Dean. Tests of the Strength of Spruce Columns, by Gaetano Lanza. On the Theory of the Moment of Inertia, by C. V. Kerr. Comparison of the Action of a Fixed Cut-off and Throttling Regulation, with that of the Automatic Variable Cut-off on Compound and Triple-Expansion Engines; Description of a Cam for Actuating the Valves of High-speed Steam Engines; Description of an Improved Steam Separator and an Improved Steam Jacket; Description of an Improved Centrifugal Governor and Valve, by Charles T. Porter. Stresses in the Rims and Rim Joints of Pulleys and Fly-wheels; The Application of Brakes to the Truck-wheels of a Locomotive, by Gaetano Lanza. An Experimental Study of the Effect of the Counterbalance in Locomotive Drive-wheels upon the Pressure of Contact between Wheel and Rail,* by W. F. M. Goss. Present and Prospective Development of Electric Tramways, by C. J. Field. Relative and Special Tests of Cast Iron, by Thomas D. West. Rustless Coatings for Iron and Steel, by M. P. Wood. The Effect of Clearance on Economy of a Small Steam Engine, by George W. Bissell. Results of Experiments to Test the Accuracy of Small Throttling Calorimeters, by D. S. Jacobus. Experiments on a System of Governing by Compression, by John H. Barr. Straightening a Leaning Chimney 100 ft. High, by Joseph C. Platt. Drawing Office Appliances, by A. W. Robinson. Strength of Railway Car Axles, by L. S. Randolph. A Graphical Method of Designing Springs, by George R. Henderson. Rail Pressures, by D. L. Barnes.

* See page 36.

AERONAUTICS.

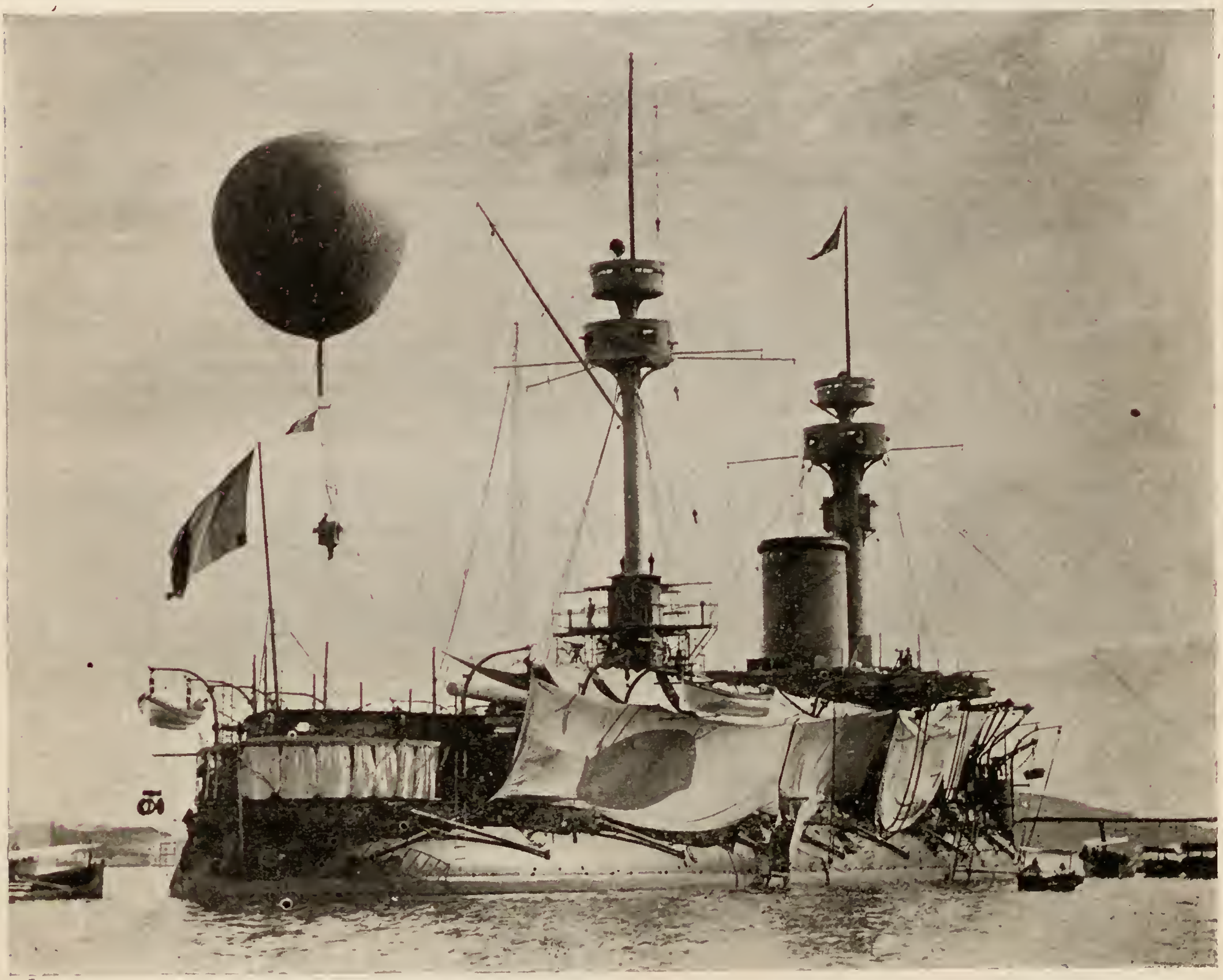
UNDER this heading we shall hereafter publish all matter relating to the interesting subject of Aerial Navigation, a branch of engineering which is rapidly increasing in general interest. Mr. O. Chanute, C.E., of Chicago, has consented to act as Associate Editor for this department, and will be a frequent contributor to it.

Readers of this department are requested to send the names and addresses of persons interested in the subject of Aeronautics to the publisher of THE AMERICAN ENGINEER.

CAPTIVE BALLOONS.

FRANCE is truly the home of the captive balloon, and the success attending their use is almost phenomenal. At the recent exposition in Lyons M. Lachambre's balloon might be said to have been *the* attraction; even before the end of the season it had made nearly 2,000 ascensions, which is without precedent, both from an aeronautical as well as a financial standpoint, and is due probably to the reputation of the aeronaut, which has fully justified the confidence that the public has placed in him. In our issue for October we illustrated the captive balloon of the Antwerp Exposition, which may almost be considered as of French origin.

Through the courtesy of *L'Aerophile* we are enabled to present an engraving showing the utilization of a captive balloon on board a warship. The vessel is the *Formidable*, of the French Navy, which is at present stationed at Toulon, where ascensions are made under the direction of a young officer, M. de Saint-Seine, and the results that he has obtained are said to have warranted the continuance of the experiments. It is merely another attempt to extend the visible horizon for strategic purposes, and there is no good reason why it should not succeed.



CAPTIVE LOOKOUT BALLOON ON BOARD THE FRENCH BATTLESHIP "FORMIDABLE."

ON THE PROBLEM OF AERIAL NAVIGATION.

BY WILHELM BOSSE.

A SHORT time ago the celebrated zoölogist, Professor C. Claus, honored the Aeronautical Society of Vienna with a lecture on "The Forms and Origin of the Organs of Flight in the Animal Kingdom," wherein he proved, substantially, that the respective species of animals were not primarily endowed with the power of flight, but that this power is the final result of adaptation continuing through thousands of years; that its primal origin is doubtless to be traced back to the leaping of climbing animals from great heights, an assumption verified by the remains and petrified casts of certain prehistoric animals.

The successful personal attempts at flight in a similar manner, by Herr Otto Lilienthal, of Berlin, are very modern and authentic proof in support of the above theory. Now, when we consider that, so far, Mr. Lilienthal's experiments have

merely shown the gliding of a species of parachute, at most prolonged by some shifting of the center of gravity, it will be readily understood that better results would be obtained if the rigid and fixed wing surfaces still employed by him were supplanted by others whose motion would promote and extend the flight.

This would, of course, make Lilienthal's simple apparatus much heavier and more complicated. Owing to our lack of experience in constructing such machines, the personal strength of the "flying man" might, for some time to come at least, hardly suffice to propel and guide the apparatus; besides, experiments with such machines may endanger the life of the experimenter.

It would be much simpler, and certainly much less dangerous, if such attempts were made on an inclined plane, down which a species of tricycle were made to roll, with whose treadle the mechanism for the actuation of the wings would be connected.

The advantages of this proposition are very evident. Above all, it removes the necessity of a costly and heavy motor; the work of starting would be rendered almost *nil* by the gravitation of the apparatus, and the treadle work of the rider would be almost wholly available for operating the wing mechanism. In this wise a speed of from 15 to 20 meters per second could be reached, which would enable us to determine accurately in what proportion the lift increases, when the machine moves in a straight path and with increasing speed—this fact having been established, but without the desirable mathematical exactitude. Finally, the rider would, through his senses and instinctively, gather such valuable information as to his apparatus and as to the air resistance to be overcome, as would show where and how the mechanism employed could be improved and perfected; in short, one could then see, feel and measure whatever happens when one passes through the air in what would at least resemble active flight.

The plane to be traveled over should be about 300 meters long, inclined at an angle of from 5° to 10°, and as smooth as possible, and the treadle power may be transmitted to the wing mechanism by toothed wheel and chain. These two factors offer ample opportunity to satisfactorily demonstrate, with the greatest accuracy, the advantages and shortcomings of any flying device.

From the foregoing it will be seen that an experimental station on the lines above indicated would promote the study of flight in general. I shall now endeavor to show how such an attempt at flight, based on my own experiences in this field, is to be conducted to promise some measure of success.

Let us suppose that we have such an inclined plane; also a light wagon, whose treadle mechanism controls not only the rolling motion of the wheels, but which, at the same time, also puts the wings in motion in the desired manner. The wing motion is produced as follows: On each side of the wagon two equal cranks are coupled by a rod, just as the driving-wheels of a locomotive are connected, the rod being parallel to the inclined plane. These rods project forward, and to the projections, at right angles to them and also parallel to the plane, is attached the main wing-arm, tapering toward the ends; from this main arm several elastic ribs, also tapering toward the ends, extend backward, parallel with and about in a plane with the coupling-rods.

This constitutes the wing-frame, which is now covered with some light stuff, which latter must project somewhat over the rear end of the ribs; such wing surface being intended to yield to the air pressure more and more toward its rear edge. Of course the coupling-rods are not covered, as that would interfere with the free display of the elasticity of the wing surface. If now this pair of wings—one on each side of the vehicle—is so connected with the treadle that with the downward movement of the treadle the wings are also moved downward, the main requirements of the system are given.

The accompanying drawings illustrate the intended wing motion as follows:

Fig. 1. *a* is a rigid portion of the wagon; *b b* are two equal cranks, rotating as indicated, and raising and lowering the bar and "wing-carrier;" *c*, which, while in motion, remains parallel to the ground plane.

Fig. 2 shows the wings on both sides of the wagon, to wit: *b b*, the crank-pins (?); *c c*, the "wing-carriers;" *d*, the cross-beam, or main wing-arm, to which the wing-surfaces are attached, and extended over the elastic ribs *e e*.

The surfaces are slightly curved upward, but, owing to their elasticity, are deflected upward during the down-stroke, so that a considerable component of the "push" causes the wings to rise again, under the influence of the forward motion, like a kite inclined at a very small angle; this play continuing on and on.

It is seen that by this arrangement the wing surfaces are, owing to the steady forward movement, continually in wave motion, the fall being steeper than the rise; the wings, which advance into the air with their sharp edge in front, receive, in almost any position, the greatest air pressure from below, so that any power expended in their operation is utilized with the least possible loss by slip. The operation of the mechanism is maintained by continual rotary motion, which easily enables its connection with the rolling motion of the tricycle, and in any case is the simplest and most advantageous for the employment of motory force.

When we consider the extraordinary sacrifices in time and money with which your celebrated Professor Langley, and also, in Vienna, our excellent engineer, F. v. Loessl, succeeded, by systematic experiment, in giving us trustworthy and useful tables on the resistance of the air, and thereby inducing a more intelligent and more unprejudiced estimation of the problem of mechanical flight, we may now, in view of the lively interest in the subject, which is so generally evinced, hope that those difficulties will also be overcome which still separate us from the solution of this great commercial and economic question. Let us endeavor, by a lively interchange and extensive publication of suggestions and successful experiments, to induce the public at large to assist us in our efforts; then we shall not lack the means with which the great work may be brought to a happy issue—perhaps before the end of this century.

HYDROGEN GAS APPARATUS FOR THE UNITED STATES SIGNAL SERVICE.

As the success of the flying machine depends upon its motor, so the achievements of the aeronaut are dependent upon the quality and kind of gas used in his balloon in order to secure the proper lift. Given a tight balloon, and hydrogen is probably the best as well as the lightest gas that can be used. A hydrogen-gas generating and compressing plant has recently been designed and built for the United States Signal Service. Its arrangement and design is clearly shown by the accompanying engraving.

A is an acid-filling vessel of No. 14 B. W. G. sheet iron, lined with lead of standard weight, 6 lbs. to the square foot, without the top, and holding 12 galls., with a ½-in. lead outlet pipe from the bottom, with a lead faucet.

B is a rectangular galvanized-iron water vessel with a capacity of 60 galls., with a 1-in. iron outlet pipe from the bottom, having a faucet at the end; this pipe is made so as to admit unscrewing it from the water vessel without leaving any outside projection.

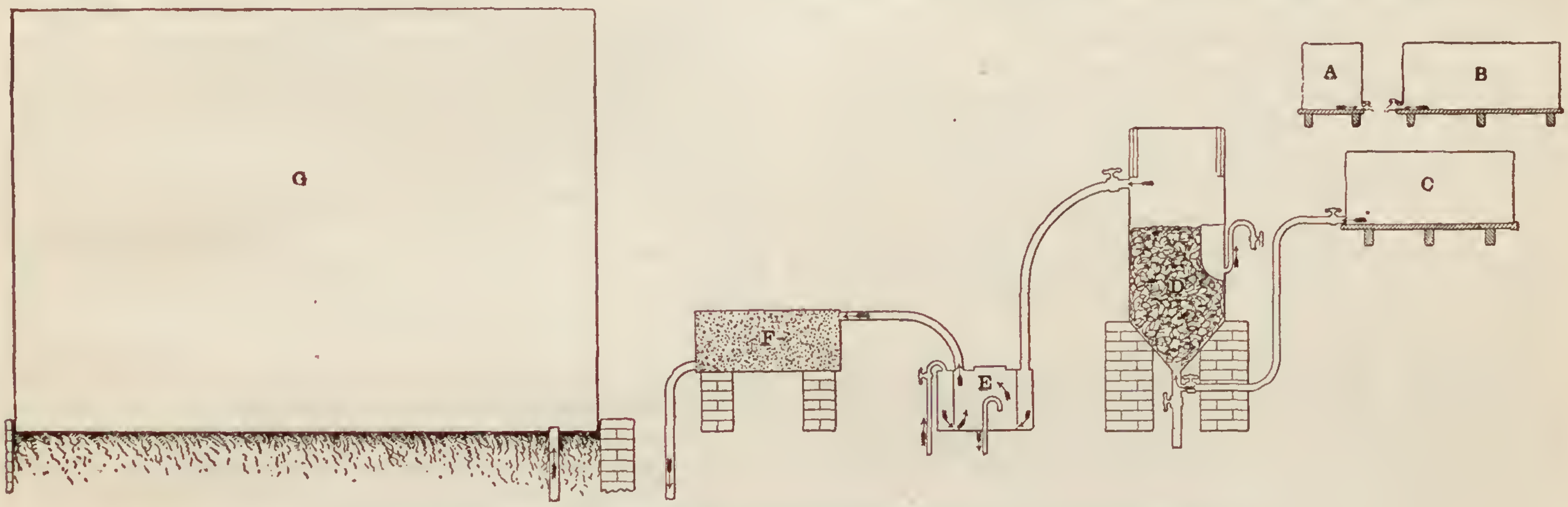
C is a rectangular mixing vessel of No. 16 B. W. G. sheet iron, lined with lead of standard weight, 6 lbs. to the square foot, containing 72 galls., and it is into this that both *A* and *B* empty when the apparatus is in use. This vessel is made so as to admit the water vessel *B* to be placed within it for convenience of transport. It has a 1½-in. lead pipe from the bottom connecting with the generator *D*, and a lead stop-cock near the entrance to the generator.

D is the generating vessel of No. 14 B. W. G. sheet iron, with riveted and calked joints, and is lined inside throughout, except at the top, with sheet lead of standard weight, 6 lbs. to the square foot; it is a cylinder 4 ft. in height by 2 ft. in diameter, with a conical bottom forming a reversed cone 1 ft. in depth, having at the apex a 2-in. orifice with pipe, a joint or union, and having inside, immediately above this orifice, a movable perforated lead disk to uphold the filings of iron or zinc and to permit of free passage of the water that has been acidulated with sulphuric acid; a 2-in. lead pipe connection is furnished for the orifice with two lead stop-cocks, one for the inlet from the mixing vessel and the other to carry off the flushings or waste when washing out the tank; the top of the generator is fitted with a round movable cover, is 22 in. in diameter, of sheet iron, the rim or sides of which is 12 in. wide, so as to drop into an annular space 12 in. deep and 2 in. wide. This annular space, when in use, contains water to make a water joint for the cover, and is formed on the *inside* of the upper edge of the cylinder by riveting a band of sheet iron around the top so as to provide between the band of iron and the side of the cylinder for a space of 12 in. deep and 2 in. wide; this sheet iron band is lead-lined on its side facing the interior of the cylinder.

The generator is also fitted on the *inside* with a water-tight lead-lined bowl, being 14 in. deep and 6 in. wide at its top, for the purpose of carrying off the overflow—the top being level and 24 in. above the base of the perpendicular side of the cylinder. On the *outside* of the cylinder, 1 in. above the height

of the *bottom* of the bowl, a 1-in. syphon pipe of lead is connected with its upper curve on a level with the top of the inside bowl, and having a faucet at its end to carry off the overflow. A 2-in. lead-lined outlet pipe (for hydrogen gas) leaves the generator just below the annular space—that is, about 13 in. below the top of the cylinder. It has a stop-cock and a coupling for the pipe leading to the washer *E*.

E is a gas tight vessel (used for circulating water through the hydrogen to free it from impurities) of No. 16 B. W. G. galvanized iron, with riveted and calked joints ; it is 24 in. in diameter by 15 in. in height. Inside this there is placed, and tightly jointed to the top and bottom, a concentric partition of the same material 4 in. from the side. This partition has a row of ¼-in. perforations 2 in. apart and ½ in. from the bottom. Over the annular space thus formed and in the top of the vessel there is placed a union for the pipe connection with the generator *D*, and in the opposite side of the top, over the annular space, there is placed a connection for 1-in. pipe to admit water. Also in the top and over the *inner* or circular partition space there is fixed a connection for a 2-in. pipe for the gas outlet. Within the inner (circular) compartment and at the center of the bottom a lead pipe bent at the upper end for a water overflow is inserted, the lower part of the bend being 7½ in. above the bottom of the vessel, and the orifice on the outside of the bottom is provided with a coupling for pipe or hose. In the center of the top of the vessel a man-head 8 in. in diameter is placed ; this is made fast and gas-tight with a gasket. A drain-cock is also provided at the outer lower edge of the vessel.



HYDROGEN GAS APPARATUS FOR THE UNITED STATES SIGNAL SERVICE.

F is a dryer of No. 16 B. W. G. sheet iron, with joints riveted and calked, and is such a size as to fit into the water vessel *B* for convenience of transportation. This dryer has a gas-tight, movable man-head 12 in. in diameter at the top, and has a connection for a 2-in. pipe, through which the gas enters, traverses the quicklime within the dryer, and passes out through a 2-in. exit pipe, the connection for which is also provided in the end of the dryer and on the opposite side from the entering pipe. Sheet-iron perforated partitions are placed inside and over the inlet and outlet orifices to prevent the lime entering the pipes.

G is a cylindrical gasometer of No. 16 B. W. G. sheet iron, 12 ft. in diameter, of a capacity of at least 1,000 cub. ft. of hydrogen at a pressure of ½ lb. to the square inch ; it is made the same as for illuminating gas, and is provided with columns, weights, and all iron work complete.

In addition to those parts shown on the engraving there is a hydrogen-gas compressing pump with a capacity of 10 cub. ft. of free gas per minute, and is capable of compressing 1,000 cub. ft. of hydrogen gas to 101 atmospheres in 100 minutes, as well as compressing it to 121 atmospheres in 2 hours, and forcing it into steel storage cylinders. The compressor is capable of working under a continuous working pressure of 2,000 lbs. to the square inch ; the parts of the pump and connections subject to great pressure are made of metal of such density as to prevent escape of hydrogen gas through its pores ; great care was taken to have the machine tight in all its joints, and show no distress of working under test of 2,500 lbs. per square inch ; the compressing cylinders are surrounded by water jackets ; the valve mechanism is of improved construction and particularly accessible for convenient examination and repair ; it is supplied with a pressure indicator ; an automatic (positive) regulator, with piping, making connection between the regulator and indicator.

The gas is compressed *dry*—that is, no water is allowed in the compressing cylinders.

The pump is driven by belt power, and is therefore provided with band fly-wheel for such an application of power.

LILIENTHAL'S IMITATORS.

It will be recollected that in giving an account of his experiments in 1893, *Herr Lilienthal* frankly invited aviators to repeat his glidings and to endeavor to improve upon them.

Mr. A. M. Herring, of this State, has been experimenting with wing surfaces large enough to carry his own weight for over a year, and has succeeded in sailing a distance of several hundred feet. He is continuing his experiments, and we give fuller information about them in another column.

In England, Mr. *A. Liwentaal*, of Dartmouth, has built an apparatus 43 ft. across, with 500 sq. ft. bearing surface, and weighing 120 lbs., with which he proposed to repeat Lilienthal's experiments. The results have not been made public, but it may be predicated that this large relative surface will expose this apparatus to many contingencies arising from even light gusts of wind.

In Australia, Mr. *Hargrave* has tried jumping into the wind with a surfaee of 150 sq. ft., disposed in four wings set at a diedral angle, but found it a flabby, unhandy thing, which turned over with him.

In France, something like a flutter of excitement was produced by the publication of the results accomplished by Lilienthal, and the French Society for Aerial Navigation voted an appropriation to repeat them. Several constructors were asked to build an apparatus exactly like Lilienthal's. The invariable response was that they would build a greatly superior apparatus. The promoters were unable to get the constructors to understand that it was not a "greatly superior apparatus" that was wanted, but one identically the same. At the last published accounts the promoters were still patiently explaining their wishes, and the members of the society were scouring the country around Paris to find a favorable location for such experiments. It is probable that they will follow Lilienthal's later example in building an artificial hill.

In Vienna, the managers of the Kalenberg Rack Railway, a place of popular resort, have purchased one of Lilienthal's soaring machines, and sent an acrobat to him at Berlin to learn the proper use of the apparatus. Upon his return to Vienna the acrobat began praetising on the Kalenberg, but this not being an isolated, conical hill, such as Lilienthal has generally selected, and finally built for himself, the wind has seldom been from the right direction, or with the proper velocity to conduct such experiments. The acrobat, although an expert tight-rope dancer, has been having a hard time of it, and according to the account of bystanders has developed a dreadful propensity "to alight on his nose."

VOYAGE OF THE BALLOON "SVEA," AT STOCKHOLM, SWEDEN, OCTOBER 19, 1893.

There has just come to hand an account of a very interesting balloon voyage at Stockholm and for 136 miles east over the Baltic Sea, made by S. A. Andrée.* The ascension was a very slow one, occupying nearly 3 hours in rising from the

*Bihang till K. Svenska Vet-Akad. Handlingar, Band 20, Afd. II., No. 3.

earth at 8 A.M. to the highest point reached, 9,900 ft.; for this reason it is impossible to make any deductions as to the diminution of temperature with height except by allowing for change in temperature as the day wore on. It so happened that Stockholm was almost exactly in the center of a high area at this time, and for this reason we ought to expect most valuable data both as to temperature and moisture. During most of the time the balloon was over a wide expanse of water—in fact, over an ocean—and this adds great interest to the observations.

The accompanying table gives the data as observed on the voyage. Fortunately an aspiration psychrometer was used,

VOYAGE OF THE BALLOON "SVEA" AT STOCKHOLM, SWEDEN, OCTOBER 19, 1893.

Time, A.M.	Pressure, in.	Height, ft.	Temp.	Wet.	Dewpoint.	Rel. Hum. Per cent.	p, in.	$\frac{p}{S}$	$\frac{p}{S}$ Phila.	$\frac{p}{S}$ Hann.
8	30.15	16	36.0°	35.1°	22°	54	.113	1.00	1.00	1.00
8.58	27.56	2,370	27.0°	23.4°	16°	58	.083	.73	.78	.76
9.20	25.71	4,150	19.6°	17.8°	14°	75	.075	.66	.73	.61
9.30	26.23	3,650	20.8°	18.9°	14°	73	.078	.69	.73	.63
9.53	23.78	6,160	16.2°	16.5°	16°	100	.085	.75	.13	.52
10.28	22.17	7,985	18.5°	10.2°	−60°	4	.001	.01	[0.0]	.37
10.32	22.09	8,080	18.9°	10.6°	−39°	16	.004	.04	.	.37
10.51	20.89	9,495	16.2°	8.4°	−50°	8	.002	.02	....	.33
....	....	9,900	....	...	....	..	...	....	....	...

and while it is probable that the results were not quite as satisfactory as they would have been with a sling psychrometer, yet they are almost perfect, and far superior to data usually obtained with stationary instruments. The diminution of temperature with height, allowing for increasing heat, was about 1° in 250 ft. in the first 4,000 ft., which is quite remarkable considering that the sea surface ordinarily causes a much less diminution with height. This was to be expected at the center of the high area, as has been shown repeatedly in this country. Above 4,000 ft. clouds were encountered, and these changed the law of diminution. At the highest point the result was 1° in 400 ft.

In the saturated stratum at 6,160 ft. the wet bulb read 0.3° higher than the dry, owing to the contraction of the ice film, as has been pointed out in this country. The most interesting point, however, is the extraordinary dryness of the air above 7,500 ft. At 6,000 ft. the relative humidity was 100 per cent., and 1,800 ft. higher it was only 4 per cent! This is the most extraordinary fall in humidity ever observed, and shows how little we really know of atmospheric conditions even at very low heights, also how much we may hope to gain by a thorough search in the ocean of air above us. At Philadelphia in 1887 the present writer observed a drop of 45 per cent. in 1,000 ft., and in 1891, in Washington, of 30 per cent. in 400 ft. This dryness is all the more remarkable over the ocean, and shows that oftentimes the evaporation and diffusion of moisture from an enormous body of water extends to but a very small height.

The last three columns in the table are constructed as follows: The vapor pressure at starting is called S, and the figures at each height are obtained by dividing p, the vapor pressure at that height, by S. In the last two columns I have given the results in the balloon voyage in August, 1887, at Philadelphia; and the last column gives the average law as determined by Dr. Hann from a great number of voyages. Here again we see the great interest attaching to the *Svea's* voyage.

Such desultory results as these obtained in single voyages serve to whet our appetites for more data of this kind. Here are conditions which no one could have dreamed of. How is it possible for such layers of extraordinary dryness to form within 1,000 ft. of perfect saturation? How long do such conditions maintain themselves? What are the conditions at 15,000, 20,000 and 25,000 ft.?—heights very easily attained and without discomfort. How are these conditions changed on the approach of a storm? The view that there are more or less homogeneous cylinders of air extending to great heights in the atmosphere is sadly broken up by all such records. We cannot hope to make a beginning even at a true science of our storms till we have obtained many such records. It is believed that 200 and more voyages to 25,000 ft. may be made for $4,000. The value of the results to be thus obtained in determining the laws of storms and in aiding in forecasting them would be incalculable. I know of no way in which a man may make a name for himself more effectually than by furthering an exploration of this kind. Hundreds of thousands of dollars and scores of lives have been wasted in getting almost nothing from the icy North, while we are content to let this enchanting field just at our hands go unexplored and unknown.

My experience in five balloon voyages—one of them to 16,000 ft.—has shown the entire safety of such exploration. Ordinary ballooning as conducted at fairs and elsewhere has called for a balloon plump full of gas at starting and the whole of it emptied at anchoring. This is a needless waste. With a balloon one-third full just as high a point can be reached as with one full; moreover, after landing, the same gas may be used over and over. The loss of gas with a gold-beater's skin balloon—and none other should be used—need not be more than 500 cub. ft. for each ascension, and this means an outlay of less than $3 per voyage. It is also probable that the unique manufacture of such a balloon could be paid for by exhibiting it during its construction. Where is the Queen Isabella who will help make this exploration of a new world?

October 13, 1894. H. G. HAZEN.

VOYAGE OF THE BALLOON "CIRRUS," JULY 7, 1894.

READERS of AERONAUTICS will remember a description of a balloon voyage to a height of 10 miles made by *L'Aerophile* in Paris, published in March, 1894, and, in fact, first published in an earlier number. It is gratifying to note that the lowest temperature computed in the above article—104° F.—has been accepted by a large number of writers abroad instead of the 256° proposed by the French savants. The balloon *Cirrus* has the distinction of having made 54,530 ft. instead of 52,280 ft. by *L'Aerophile*, and the voyage deserves more than a passing notice. *Cirrus* has a capacity of 8,760 cub. ft. Its envelope, net, etc., weighed 93 lbs., and the apparatus for registering temperatures and pressure, 6 lbs. It was inflated at Charlottenburg, near Berlin, with coal gas, which has a lifting power of about 40 lbs. to the 1,000 cub. ft. The buoyancy of the balloon was about 250 lbs., and it is stated that when the tether was cut the balloon flew (popped) into the air like a champagne cork. In the first 5 minutes it rose a little over 9,000 ft., or 30 ft. per second; but this velocity was greatly diminished in the next 5 minutes. The balloon sailed in a south-southwest direction, and was found, about 11 hours after the start, near Zvornik, between Bosnia and Servia. The distance traveled in 10 hours was about 622 miles, which gives a velocity of 62 miles per hour. This velocity was the greatest ever recorded for so long a voyage, though the distance covered was not as great as in the voyage by Professor Wise from St. Louis to Henderson, N. Y., in which he traveled 46 miles per hour for 19 hours.

The following table gives the principal observations that have been published of this voyage. The balloon was so long in the air that there appears to have been no downward trace, which is to be regretted. It will be noted that the velocity of

HIGH BALLOON VOYAGE OF "CIRRUS," JULY 7, 1894.

Time, A.M.	Pressure, in.	Height, ft.	Velocity ft. per sec.	Temperature.	Dim. per 1,000 ft.	Probable Temp.
3.40	30.08	130	..	63°	....	63
3.45	21.65	9,180	30	45°	2.0°	45
3.50	17.32	15,030	20	28°	2.9°	28
3.55	13.39	21,520	22	5°	3.5°	5
4.00	9.84	29,280	16	−13°	2.3°	−15
4.5	7.87	34,460	17	−31°	3.4°	−32
4.10	6.30	39,230	16	−45°	2.9°	−46
4.15	4 92	45,420	19	−52°	1.1°	−62
4.20	4.33	48,200	10	−58°	2.0°	−70
4.25	3.74	51,680	12	−63°	1.4°	−78
4.30	3.35	54,530	10	−62°	−0.3°	−86

the balloon diminished very greatly as it rose higher and higher, and it is probable that on this account the apparatus was heated by the sun, and failed to record the temperature as low as it should have done. I have given the probable temperature in the last column as determined from the law at the lower levels. While such balloon ascensions must add to our knowledge of the conditions in the upper air, at the same time it cannot be said that they are very satisfactory; there is altogether too great an uncertainty in the results, and the very important conditions of electricity and moisture are not given at all. What we need most of all now are ascensions up to 30,000 ft. with perfect apparatus and observers in the balloon. Such ascensions can be made at much less expense than is usually considered possible, and it is to be hoped that they may be started ere long. H. G. HAZEN.

October 8, 1894.

BALLOONS IN THE BRITISH ARMY.

A correspondent of the London *Times*, in writing about the training of the army at Aldershot, says:

"The other form of reconnoissance—aerial, that from balloons—has, whenever it has been found practicable, proved to be of the greatest value; but the tempestuous weather has prevented its frequent employment. On this account there is a dead set against balloons, and there are heard many growls against allotting any portion of our scanty transport for the carriage of that which can be so seldom used. If any one wishes to be convinced how penny wise and pound foolish we should be to abandon this but lately started form of reconnoissance, let him take the whole of the battles of 1870–71 and sit down and calculate not only what would have been the saving in blood, but in hard money, if, on any one of these days, either side had been able to send up a balloon with practiced observers in the car. It is because in peace time the inestimable value of information regarding the enemy's dispositions is not realized; it is because dispositions based on defective or incomplete information are not paid for, as they are in war, with defeat and loss of lives, that soldiers fail to understand the full value of accurate information. Moreover, at Aldershot the balloon has never had a fair trial; it has been employed for more tactical work and not for the manœuvring work, and this because the latter has not existed. It is sent up simultaneously with the advance of the troops to the battle-field instead of being sent up at daybreak to obtain information as to whither that advance should be. When our training resembles the work of modern war, and when manœuvring occupies the foreground, loud will be the demands for a balloon; but even when used tactically it has been a success. At the operation near Cobham Ridges on July 25 the balloon observers reported to the attacking force an approaching strong counter attack. So little did the general know of his enemy's dispositions that he would not believe the report. Shortly afterward, however, the counter attack took place. On two other occasions the balloon observers kept their side constantly informed of the dispositions of the hostile forces in the battle. The balloon now works in conjunction with the field telegraph; written reports are passed down by 'messengers' along the cable of the captive balloon to mother earth, where a telegraph station is ready for their reception. The other end of the telegraph wire has been carried to the point in the battle-field where the general has taken up his stand; if he shifts, the wire is laid on to his next position, so that the balloon itself can remain well in the rear of the fight and yet communicate rapidly with the commander. It may be here mentioned that another form of aerial reconnoissance is in the experimental stage; it consists in raising the observer by means of a kite, the contention being that the worse the weather for a balloon the more suitable it is for the kite. Both Lieutenant Baden-Powell, of the Scots Guards, and Captain Pilcher, of the Northumberland Fusiliers, are engaged in working out this problem, each in his own way; but at present neither solution has reached the practical stage.

WELLNER'S FLYING MACHINE.

We illustrated and described in Aeronautics for June, 1894, Professor Wellner's flying machine, which, when first proposed before the Vienna Association of Engineers and Architects in the preceding November, excited such confidence and enthusiasm that a sum of 5,000 florins was immediately raised to build an experimental machine or sail-wheel.

This sail-wheel, it will be remembered, presents in side view the appearance of a large reel, such as fish nets are wound upon, and consists of a series of feathering air paddles, each connected by two radial rods to a central eccentric, so as to alter their angle of incidence while rotating, the maximum lifting effect being produced when the paddles are at the top and bottom of their course and they presenting only their sharp edges to the air on the quarters. The wheel was to be incased in thin canvas to confine the resulting air currents, and thus resemble a drum open at the ends, beneath which was to be hung a car containing the machinery.

We understand that an experimental sail-wheel has been built in Vienna and is now being experimented with. It was planned to be 5 meters (16.42 ft.) in diameter and 2 meters (6.56 ft.) long, and to have a circumferential speed of 45 meters (147.6 ft.) per second. The testing power was to be furnished by electricity.

It is said that in the first trial the sail-wheel became distorted before it reached a peripheral velocity of 32 ft. per second. It was then improved and stiffened at the expense of weight. In the second trial it reached a velocity of about 50 ft. per second and remained uninjured, but a greater velocity could not be attained; and this was attributed to defects in the dynamo and gearing. Alterations are being made, and the trials are to be resumed.

The sail-wheel as reconstructed weighs 396 lbs., and *must* attain a velocity of nearly 150 ft. per second in order to lift itself up. At 50 ft. per second the lift was only 88 lbs., so that it seems very doubtful whether the wheel can ever attain sufficient velocity to lift itself up before breaking, or else it will have to be reconstructed and strengthened so that the weight will become greater than the lift.

Herr Wellner is Professor of Engineering and Machinery Construction at the Technical School at Brünn, and is deemed a very able man, with great originality and magnetism. He has given much attention to aerial navigation, having made numerous experiments on air resistances, both in the wind and on moving railway trains, and published quite a number of papers. At first he promoted balloons, having constructed in 1883 a very novel form of wedge-shaped balloon, which the *L'Aéronaute* compares to an ill-shaped sausage (*un saucisson mal fait*), and which proved a dead failure; but it is to be hoped—although it does not seem likely—that his sail-wheel, which is equally novel and original, will have a better fate.

Since the above was written we have received the following information: After considerable interruption, and after improving the wheel, Wellner's experiments have been resumed. The best result obtained was 80 revolutions per minute, or 65 ft. circumferential velocity per second. At this speed the wheel became dangerous. On one occasion one of the sail-surfaces was split, then the wheel became distorted—in short, the experiment had to stop. The uplift actually obtained reached 132 lbs. The experiments have now been discontinued, probably for good, as there seems to be no prospect of reaching the required speed of 150 ft. per second.

PROFESSOR WELLNER ON THE SAIL-WHEEL EXPERIMENTS.*

"I am firmly convinced that the realization of a dynamic flying machine lies within the limits of technical possibilities, and I cling to the hope and expectation that a practical solution will soon overcome the surrounding difficulties that beset the problem and shed new honor on our Fatherland." It was with these words that Professor Wellner concluded his report to the Oesterreichichen Ingenieur und Architektenverein at a recent session regarding the experiments that have been made with a sail flying machine,† built under the patronage of the society. Although these experiments have not yet been concluded, the results that have thus far been obtained go to show very conclusively what the efficiency of the sail-wheel may be. Professor Wellner began his explanations amid great applause and by rendering hearty thanks to Professor Radinger, through whose assistance the experiments have been rendered possible. A committee of 12 members, with Professor Erner as chairman and Professor von Hausse as vice-chairman, had taken hold of the problem and designed an experimental wheel of large dimensions with stationary bearings. The General Electric Company of Austria, Siemans & Halske, Brand & Lhullier, of Brünn, and Schimeczek & Anderle, of Vienna, took part in the construction of this sail-wheel; and by the end of last June it was completed and set up. During July, August and September careful experiments were made, which were soon brought to an end on account of the inclemency of the weather.

Professor Wellner then unfolded to the numerous and interested audience, that was closely following his report, the conception and original scheme of construction of the sail-wheel that had been built, and introduced a small two-sail model of the wheel with screwed ribs, by the rotation of which at the end of a long arm the rising and forward motion was demonstrated; from which the following conclusions were evolved: "From all the experience that has thus far been obtained, I have deduced a confirmation of my firm convictions, that the solution of the problem of dynamic flight is a possibility. This is also demonstrated by the physical investigations made in Vienna by Professor Boltzmann. He prophesied the possibility of flight by aeroplanes while I pinned my faith to the screw and sail-wheels, as giving the greater stability in a forward motion. The results obtained

* Abstract of report to the Ingenieur und Architekten Verein.

† See Aeronautics for June, 1894.

SOARING EXPERIMENTS OF A. M. HERRING, NEW YORK.

with the large, light, and skilfully built aeroplane machine of Mr. Hiram S. Maxim, the inventor of the rapid-fire gun, which was tested during the past summer on a specially constructed track in England, were practically the same as those which I had obtained with oblique planes on railroads, but the Maxim investigations came to grief on account of the lack of a proper steering apparatus, which resulted in the breaking of one of the holding-down rails and tipping the machine over on one side. This disastrous action of the Maxim flying machine considerably surpassed that of the sail-wheel. The problem which must be solved in the building of a serviceable sail-wheel flying machine consists, in the first place, in the overcoming of constructive difficulties, which can readily be done by the choice of the best materials, as well as by the employment of the most skilled labor; and, in the second place, by a research for the most efficient motors. The circuit of practical observations regarding aeroplanes, air screws, and sail-wheels is about closed, and the solution lies before the eye."

Great interest also centres about the efficiency developed by special types of construction, such as steam-engines, steam turbines and other motors, which may contribute to the perfect feasibility of the flying machine. In like manner the use of ammonia, carbonic acid gas, illuminating gas, benzine and other materials that require another type of construction in the motors may have its influence on the final solution. Professor Wellner places the benzine motor in the front rank, at present especially for small flying machines, because with it the steam boiler can be discarded, and the fuel that is used and which the engine requires has no very great weight.

"SOARING" EXPERIMENTS.

We are gratified to be able to give herewith engravings of another soaring machine which has been constructed and successfully experimented with by Mr. A. M. Herring, of this city. Of this machine and his experiments Mr. Herring says:

"I have in a measure repeated the 'soaring' experiments of Mr. Lilienthal, and have in some respects met with success. During the summer I constructed two machines, the first being about 20 ft. × 7 ft. 6 in., and subtending about 130 sq. ft. of surface, curved in such a manner as to form approximately two shallow portions of a sphere set at a slight diedral angle with each other. It had no sails, but the equivalent of a horizontal one was furnished by a slight reversal of the curvature of the centre radials. This machine, all told, weighed less than 15 lbs.; all the wood-work was carefully made from well-seasoned, perfectly clear, straight-grained spruce, all unnecessary material being cut away in every place except where the maximum strains came. Metal-work was avoided wherever possible, but when used it was thin sheet steel carefully hardened and then tempered to a blue color; what few bolts there were were made of French steel tubing, with portions brazed on which carried the head and the treads. The balance of the metal work consisted mainly of fine piano steel wire, about 600 ft. for guys, stretchers, etc., and hollow steel rivets made of seamless steel tubing, which had been made very thin by reaming out the inside. The fabric was thin Nainsook muslin soaked in a diluted solution of shellac varnish, which was mostly squeezed out by wringing before the cloth was stretched in place, the stretching being done while the cloth was still damp. This gave considerable firmness and tension to the surface by reason of the Nainsook shrinking as it dried. With this machine I made a few short flights, most of them under 50 ft. in length. It was much too delicate a machine to begin to learn with, and consequently was soon broken through lack of skill in handling. It distorted but very slightly under my weight (about 155 lbs.). However, under very skilful handling in mild weather, I think it would have been quite strong enough. The next machine, which was of very nearly the same shape and dimensions, was made in parts of the remains of the first. It was furnished with a horizontal lifting rail. Most of the beams were new and much heavier. It was built for rougher usage, which it has stood very well indeed. It weighs 26½ lbs. Unlike Mr. Lilienthal's machine, I did not adopt a vertical rudder or rail. With the second machine I have made a number of short runs. Observing the wind velocities between many of the trials with feathers and thistledown, I found by timing that my own velocity varied from 9 to about 15 miles per hour, and that of the wind from 7 to 12 miles. The speed of the machine appeared to be under 25 and over 21 miles an hour in reference to the air. Although I feel safe on the machine, I am hardly more than the merest beginner so far as skilful handling is concerned. Consequently a compilation of the results obtained would be of very little value, as they differ very widely. The distance travelled compared to that of the fall (both carefully measured) give flights all the way from 3½ to 16 times the fall—that is, at the rate of 40 to 210 lbs. carried per H.P. Of course I have no motor on my apparatus, and, as a consequence, all the trials were made down hill. As there was much likelihood of any results being greatly vitiated by the unknown factor of the vertical trend of the wind, I have made some experiments to determine how great this error could be. On a hill whose side sloped at the rate of 1 to 4, I found that the trend varied from a descending one of 4 per cent. to an ascending one of 18 per cent. when measured about 4 to 5 ft. above the ground; but the results in no place were constant, nor were the results alike or similar for the top and bottom of the hill. Roughly speaking, however, there was a greater ascending trend near the top than at the bottom. I found it to average about 6 per cent. near the top, and to average less than 1 per cent. at the bottom.

"The first of these machines carried a projected surface of 129 sq. ft. and weighed about 15 lbs.; the second spread 132 sq. ft. and weighed 26½ lbs. Since then still another apparatus has been built and tried. It is shown in the engravings herewith. It spreads 158 sq. ft. and measures 21 ft. 8 in. from tip to tip. Its weight is a slight fraction over 19 lbs. This machine is provided with a small vertical and also a horizontal rudder. Its general construction is on the same general principle as a cantilever bridge. In this last machine I have been able to overcome entirely the fluttering of the fabric, and by means of the movable auxiliary surfaces have been able to maintain an approximately constant angle of advance. I have been able to preserve my balance without the extreme muscular efforts which were necessary with the two first machines. Such a machine flies at less than 20 miles an hour, and would require from ½ H.P. to 3 H.P. to maintain it with one person in the air. I have designed an oil motor of 6 H.P., which will weigh less than 36 lbs. complete. The cost of constructing a simple soaring machine, such as the photographs show, is, including labor, between $150 and $175. The cost of building the oil motors would be from $450 to $700."

The people who are interested in this subject will await with a great deal of interest the further experiments of Mr. Herring, and also of others who are working in this direction. There is now good reason to believe that soaring for considerable distances and heights with proper machines is no more difficult to achieve than riding on a bicycle is; the great obstacle in the way of success in this direction is the cost of such apparatus and its extreme fragility.

THE FLIGHT OF BUZZARDS.

A number of communications were received on this subject which were intended for publication in Aeronautics, but owing to the great bulk of the Proceedings of the Aeronautical Conference, which occupied all the available space in that paper, room could not be found for them. The following communications, although somewhat delayed, seem to be of sufficient interest to justify their publication in our new aeronautical department:

To the Editor of Aeronautics:

Two coincident communications appear in the third number of your journal on the Flight of Buzzards. As I have had those interesting flyers in view, with the purpose of studying their soaring powers in connection with the subject of aeronautics, I venture to dissent from the views of both your correspondents in relation to the rapid muscular vibration of their wing feathers. There is absolutely no mechanism in a buzzard's wing, or in that of any other soaring bird, by which the wing feathers are rapidly vibrated. Your correspondent may have been misled by a tremulous movement of the tips of the wing feathers, caused by the action of the air upon them when distended.

The wonders of flight are so great as to often mislead very careful and elaborate investigators, and to give rise to theories of complex and elaborate movement growing out of a misinterpretation of the observed phenomena. Pettigrew, a most careful observer and student of animal mechanism, attacks Borelli's theory, and also ignores aeroplanes, setting up in their place a compound action of the wings wholly irreconcilable with the obvious movements of soaring birds or butterflies. The fanciful theories of Pettigrew will hardly be sustained in their elaborate and complex movements in nature; and the compound action described by him is not warranted by the bird's anatomy. Neither Borelli nor Pettigrew nor Marcy take into account the soaring on the aeroplanes of quiescent wings that are now attracting the notice of investigators.

I do not intend in this note to engage in an elaborate discussion of the mechanism of a bird's flight, for I believe that it will not materially aid the mechanician in navigating the air automatically. I only desire to direct attention to the great liability of the most careful students of aeronautics to run into error in discussing unsolved problems in this marvel of locomotion.

While I feel a very great interest in the elaborate mathematical dissertations with which your pages are filled, I believe no practical advance can be made until experiments are systematically inaugurated with actual mechanical volants, which should precede rather than follow mathematical deductions.

FORTRESS MONROE, VA. J. J. GREENOUGH.

[We coincide most entirely with our correspondent in the remarks contained in his last paragraph, and don't believe that any human or other being will ever be able to achieve flight by means of mathematical gymnastics.—EDITOR AMERICAN ENGINEER.]

To the Editor of AERONAUTICS :

My observations on buzzards so far are that the end feathers of the wings are the rudders of the ship. They turn and twist sidewise to keep the balance and direction in a vertical line—that is, to raise or lower the line of flight. They all turn together, but do not beat the air at all except when the whole wing beats. When the end feathers are very suddenly turned at a sharp angle to the direction of flight, and the bird is sailing fast, the back edges of the feathers, which are furthest from the stem, quiver in the wind on account of its force against them just as a piece of paper or anything else similar would when forced at an angle against the wind. That is probably what gives the idea that the feathers are beating. The front part of the feathers do not move at all except as the feather turns in its socket to do the steering. When the bird is sailing low it is constantly twisting those feathers to keep its direction. C. P. YEATMAN,

Chief Engineer Cucuta Railroad.

CUCUTA, COLOMBIA, S. A.

RISING.

FREDERICK, MD., December 17, 1894.

To the Editor of AERONAUTICS :

I have been making almost continuous experiments in aeronautics for the past 10 years, and have carefully observed the sailing and soaring birds, so far as they can be seen in the Middle, New England and Western States. I have seen the buzzard arise from the side of a carcase on level ground without any previous running ahead. I have seen the common tame goose standing still and by vigorous flapping of the wings raise itself off the ground without any previous advancing against the air, and I think any bird can do the same if they would but know enough to try. I have seen the turkey buzzard soaring within two yards of my position on White Rock, Catoctin Mountain, Maryland, and there was not the slightest movement of the feathers of the wing. I have seen them describe an undulatory course, as I was on a level with their line of flight, and there was scarcely any breeze whatever ; still they maintained their course with probably a single flap of the wings once in 10 minutes.

The conclusion to be drawn from above is that the air—what little was moving—had an upward trend ; and I believe it always has, more or less, an upward trend, which can be proven by holding a little dust in the breeze. As the dust is blown away it will invariably rise higher than its starting point. I also believe a flying machine will not be successful until it can lift its own weight, together with the operator, from a position of rest, and then when a foot or so off the ground to advance ahead in any direction. This would insure perfect safety in alighting and would give perfect control of the machine.

I believe also that a man has power sufficient to do this without the assistance of any other motor. I do not intend to use any gas chamber to lighten the weight, but to depend exclusively on the mechanical arrangement and adaptation of the means we have at hand. It can be done, and will be done shortly, and I expect to do it, notwithstanding Maxim, Langley, Lilienthal, Wellner, and others say that it is impossible for a man by his unaided strength to lift himself on the air.

Respectfully yours,

CHARLES ZIMMERMAN, M.D.

Professor Langley's Recent Experiments.—The New York *Herald* has recently published an account of some experiments which, it is said, were made near Quantico, a village on the Potomac River, about 30 miles from Washington. After divesting the account published in that paper of the reportorial moss in which it was invested, the statement remains that the professor made a trial of an aeroplane machine, the propelling power of which is a steam engine and two screws. The "field" workshop—the *Herald* reporter said—was "a small building erected upon a scow. Before the start the machine is suspended in a light frame rising from the roof, the principal feature of which is a long inverted track." Giving rein to his reportorial imagination, the writer in the *Herald* said : "The body (of the machine) glistens like burnished silver in the sunlight. The material in it is aluminum, and the shape like that of a porpoise. The wings are inclined upward at a slight angle, the machine being sustained much as a kite is held in mid-air."

Of the experiment itself, the *Herald* writer said :

"The propeller began a business-like whir, and the tension having reached the proper degree, the machine was released.

"Then the sight was impressive. Like a monstrous swan it jumped into the air in the face of a perceptible breeze, and, after sailing gracefully for some distance, alighted upon the surface of the water. It is made to float. Quickly followed by the rowboat in attendance, the apparatus was brought back and safely housed, whereupon the secretary and his assistant were taken ashore.

"In a general way the sailing monster suggests a gigantic swan. But to picture it in mind more exactly as it rose from the scow, one should conceive a pure white butterfly, 10 ft. from tip to tip of wing, the posterior pair, however, being detached from the anterior and much smaller. In the rear extends a vertical tail or rudder."

This machine, it is said, is tested about every week, and, as might be expected, many modifications which are suggested by the experiments are made.

RECENT AERONAUTICAL PUBLICATIONS.

WE shall hereafter publish brief references to such publications and articles concerning Aeronautics as seem to possess interest for our readers.

Mechanical Flight. Thomas Moy. *Knowledge*, London, December, 1894. Intimates that the screw propeller is not the most efficient instrument for flight.

Pressure of Wind. Professor W. C. Kernot. *Engineer*, London, November 9, 1894. Experimental determination of pressures, with shape and inclination of surface affected.

The Eddy Tailless Malay Kites. W. A. Eddy. *Scientific American*, September 15, 1894. Mr. Eddy describes his experiments with tandem kites, and the construction of his kites.

An Interview with Mr. Maxim. J. Bucknall Smith. *The Strand Magazine*, London, December, 1894. Gives a very interesting account and illustrations of Mr. Maxim's various achievements.

Aerial Navigation. A. F. Zahm. *Journal of the Franklin Institute*, October and November, 1894. An able lecture delivered January 5, 1894, giving a very good account of "the state of the art."

Locomotion in Air. H. S. Hele-Shaw. *Proceedings Liverpool Engineering Society*, October, 1894. The president's inaugural address, passing in review the present status and prospects of aerial navigation.

A Problem in Mechanical Flight. George E. Curtis. *Annals of Mathematics*, vol. viii., No. 6, p. 165. An investigation by the aid of higher mathematics of the effect of wind pulsations upon a soaring plane.

Experiments in Aeronautics. H. S. Maxim. *Journal of the Society of Arts*, London, November 30, 1894. A lecture by Mr. Maxim, describing and illustrating his machine and experiments more fully than has previously been done.

On the Resistance of a Fluid to a Plane Kept Moving Uniformly in a Direction Inclined to it at a Small Angle. Lord Kelwin. *Philosophical Magazine* (British), October, 1894. Lord Kelwin analyzes theoretically "the law of the angle," and proposes a new formula.

On the Duration and Lateral Extent of Gusts of Wind and the Measurement of their Intensity. W. H. Dines. *Quarterly Journal Royal Meteorological Society*, vol. XX., No. 91, July, 1894. Gives experimental data to show that a record of the *mean pressure* and of the *maximum pressure* cannot be obtained by the same instrument in consequence of the gustiness of the wind.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

Formerly the RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

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NEW YORK, FEBRUARY, 1895.

EDITORIAL NOTES.

THE paper on the application of water-tube boilers to warships is concluded in this issue, and contains such valuable conclusions that we call the attention of our readers to the matter as being one especially worthy of notice. The writer is evidently of the opinion that the advantages of this type of boiler so far outweigh those possessed by boilers of the ordinary construction, that they cannot fail of an ultimate adoption on all vessels.

ON the principle that misery loves company, it may be a sort of melancholy satisfaction to the naval authorities of the United States and Great Britain that they are not the only ones that have had trouble with unstable warships. It seems that the French Navy are in a similar predicament, and that the battleship *Magenta* is now undergoing some costly alterations that have been deemed necessary on account of its remarkable behavior at sea. The strange part of it is that the French builders have, after the defects were discovered, made apparently the same mistake with the battleship *Brennus*.

THE Carnegie Company seem to be in luck again. Their first luck consisted in the remittance of a part of the fine that was imposed upon them for underhanded work in the matter of certain armor plates, regarding which there has been somewhat of a scandal. Now a Washington despatch states that a plate representing a group of plates for the *Oregon* was submitted to a ballistic test at Indian Head and failed to pass, whereupon the whole group was rejected. Then an investigation was held, and it is asserted that it was found that the test was more than the ordinary service charge, and that the plate was weaker than those that it represented ; so the Secretary has decided to accept the plates, especially as the Government agent at the works asserts that the remainder of the plates will come up to the requirements.

To the ordinary visitor it would appear that the battleship of modern construction is about as near fire-proof in its construction as it is possible for it to be. It seems, however, that there is room for improvement in this direction. The Yaloo fight showed that there was considerable danger yet remaining from the use of wood, and several of the Chinese ships were badly crippled during the battle by fire. Investigations are therefore being made to ascertain whether it will not be possible to lessen the amount of wood that is used. It is proposed that the ceilings and sides of the living spaces of the vessels shall be lined with iron or *papier mache*, or some other substance that is less inflammable than wood ; that iron ladders shall be substituted in the place of wood ; and that the facilities for the storage of inflammable materials shall be improved as well as those for extinguishing such fires as may occur. It is a factor deserving of careful attention, but in making such substitutions equal care must be exercised that danger from dampness is obviated as well as the danger from fire.

WHEN the question of an increase in the number of large vessels in the navies of the United States or Great Britain is under consideration, the party favoring such an increase has usually been divided into two camps—one advocating the construction of heavy battleships whose speed is comparatively slow, and the other urging that a high-speed cruiser will be most efficient in time of war. As there had never been a battle fought between modern battleships until the Yaloo fight in the Chino-Japanese War, there has been no means of deciding as to which party was in the right. That fight seemed to demonstrate very clearly that intelligence and discipline have about as much to do in the deciding of naval battles as they ever did, but the question of battleship *versus* cruiser cannot be said to have been definitely settled, on account of the evident fighting superiority of the Japanese forces. In the report of the engagement submitted to the Navy Department, it is asserted that the Chinese heavily armored ships were practically uninjured by the Japanese fire, which is considered as tending to bear out the arguments in favor of the battleship as against the cruiser, and it is expected that it will be offered as such to the Naval Committee.

THE SCRAP PILE.

AT the November meeting of the Western Railway Club, Mr. J. N. Barr, Superintendent of Motive Power of the Chicago, Milwaukee & St. Paul Railway, read a very interesting and what ought to be a very profitable paper to many railroads, the purpose of which was to indicate how the material which has failed and is sent to the scrap-pile may be utilized to best advantage. As Mr. Barr has well said, "In hundreds of ways the scrap-pile tells the story of thrift and intelligence, or the reverse, on the part of the men who have charge of the mechanical work along the line of a railroad." He might, and in substance did add to this the statement that the thrift and intelligence of those who have charge of the mechanical work may also be indicated by the uses which are made of this material after it has been condemned. The general purport of his recommendations was, that the miscellaneous material which goes into the scrap should be assorted and classified, so that it will be available for such uses as it is adapted for. To carry out this idea, he recommends that "all material unfit for further use should be shipped to one central point, which should be located at the main shops, and such as

can be profitably converted into good material or can be used again should be separated from that which is merely scrap.

It was pointed out in the discussion that it was useless to preserve all kinds of scrap for further use, if it was kept in a confused heap or scattered about, so that when any particular thing was needed more time had to be spent in finding it than the material was worth after it was found. One speaker (Mr. Waitt) related that the foreman of the blacksmith department of the shop of which he first had charge "was all the time saving pieces of round and square iron, piling them up, supposing he was placing them where he could lay his hand upon them, but whenever there was use for an article he had, he never could find it." He, Mr. Waitt, "at last came to the conclusion that it would be better to clean out the accumulations of months or years, rather than to spend two cents to get one and a half out of it." Other speakers called attention to the same aspect of the question. Mr. Forsyth thought that any effort to classify scrap and get it into shape for market results in the scrap being handled quite a number of times, and there is the danger that the cost of the labor expended on it will equal the value of the material. Mr. Barr himself, the author of the paper, said that the cost of handling material must be carefully watched, and cited a case of their effort to make hand-hammers from old Krupp tires. They cost $8.98 per dozen, whereas new ones could be bought for $4.50 per dozen.

A short time ago the *Iron Age* published an article containing some calculations with reference to the value of wire nails and of a carpenter's time, in which it was shown that such nails were now so cheap that it did not pay to have a workman pick one of them up if he let it fall, as the time consumed in picking it up was worth more than the nail. This same principle may apply to the utilization of scrap, and it is evident that to make a profit by re-using old material which has been condemned, a good deal of horse sense or business ability must be exercised. The value of Mr. Barr's paper consists chiefly in his description of the special means and methods which he has adopted and which he has found were economical. Of these he says:

"In handling bolts, for example, a bin is required in which all bolts are deposited as unloaded. The crooked bolts are taken to the blacksmith shop to be straightened, and they and all straight bolts are then taken to the storage bins. These bins are divided into compartments, so that all old bolts of the same diameter, and which will make good bolts of equal lengths, are placed in one bin. These compartments are all labelled. For example, there is a row of compartments carrying bolts 1 in. in diameter. The first one is labelled 1 × 15 in., which is the longest bolt in general use. The next is labelled 1 × 14 in., and so on down to the shortest bolt in use. All bolts which by trimming and recutting can be converted into a good bolt 10 in. long and no longer are placed in the compartment labelled 1 × 10 in. The bolt itself may be longer than 10 inches, but the necessary trimming will bring it to that length.

"The bolt bins are located conveniently to the shop in which the machinery for cutting round iron and threading bolts is located. When the shop receives an order for, say, 100 bolts 1 × 10 in. in length, 100 bolts are taken from the compartment labelled 1 × 10 in. These bolts are taken to the shears, and if any longer than 10 in., the surplus metal is sheared off. They are pointed and threaded, and are then in shape to be shipped. It should be observed that in handling bolts in this way the expense of heating and heading is avoided, and this expense nearly if not quite offsets the cost of handling and straightening the old bolts, so that the difference between the cost of bolts obtained in this way and bolts made from new material is just about the difference between the cost of new round iron and scrap."

The short ends of bolts are manufactured into track bolts, and it is proposed to erect a set of small rolls for the purpose of re-rolling various odd sizes of iron, and reduce them to one diameter, which would be most desirable for ordinary use.

Nuts are also assorted, and as many of these have had their threads injured, it is necessary to retap them. To do this they must be compressed sideways in order to get a good thread. Dies have been fitted to a bolt-heading machine for this purpose. The nuts are then pickled in a weak solution of hydrochloric acid to remove rust and thus prevent undue wear to taps. The results of handling nuts in this way have, however, not been as satisfactory as is the case with bolts, but Mr. Barr was of the opinion that a large supply of nuts could be obtained in this way at a lower cost than that of new ones.

Crown-bar washers have also been made successfully from old material, and centre pin-plates in sufficient number for all new cars can be obtained from scrap sheet iron if this is straightened and sheared to the right size. Sheet iron is assorted with reference chiefly to its thickness, but also to its condition, and it is thought that a supply of washers could be obtained from this material if suitable punches for making them were provided. Mr. Barr also expressed the opinion that a small set of rolls for re-rolling plates to the required thickness would be a useful adjunct to the scrap department. His general recommendations are that the scrap-pile should be placed in charge of intelligent persons, the scrap should be systematically assorted, and the requisite appliances for handling and "rejuvenating" the scrap economically should be adequate for the purpose for which it is intended.

In the discussion which followed the reading of the paper, objection was made to the expense of a furnace of sufficient length to take in the iron that would have to be rolled down. To this the author of the paper replied that he could not see why the iron should not be cut to convenient lengths, which would permit of the use of medium furnaces if this were more convenient. Mr. Barr also explained that since his paper had been written they had improved their methods of "rejuvenating" nuts. Previously their treatment of old nuts did not show that any money was saved. He had, however, taken a bolt-heading machine and removed all the levers which operated the dies, leaving the one plunger which upsets the head. "The machine was so arranged that this plunger forces the nuts through a hole in a die, and presses them to size just as fast as the boys can drop the nuts into position." Mr. Barr also called attention to the fact that many things were sent to the scrap pile which were perfectly good for further service, and he recommended that more diligence and care should be exercised by those who condemned material and sent it to the scrap pile. He cited the case of broken bolts with good nuts on them—the bolts should be scraped and the nuts saved.

Mr. Manchester, an assistant of Mr. Barr's, related their experience and difficulty in using up old tires. Making hammers of them did not prove to be profitable, but they are now making certain dies and forms used in and around the blacksmith shops, and such articles as spike mauls, coal hammers for locomotives, lining-bars, claw-bars, and some kinds of wrenches have been made at a profit out of scrap steel tire.

In the case of coiled springs, they had condemned the bad coils in a set and saved the good ones, and were thus able to form complete good sets. From old double-elliptic springs they had been stamping small wrenches, spindle kegs, equalizer fulcrum plates and other small articles, but not enough to use up all the condemned springs. Recently he had been making track plates of them—that is, plates on which the movable rails of switches bear. They made an arrangement with which they sheared the plates in a "bull-dozer" and punched two square holes in it at one operation, the plates being heated for that purpose. Old flues they are using for making the gratings of cinder-pits, which are used for clean-

ing out the smoke-boxes of locomotives, and are thereby effecting a saving of 50 per cent. over what they cost if made of new material, and the tubes make better grates than those made *de novo*.

Old fish-plates are made into rail braces; broken centre pins are re-welded; crooked links, which are not cracked, are straightened. "All scrap when it arrives is assorted and sheared to proper lengths for what it will make, and it is then piled with the iron that is to be used for that purpose. At West Milwaukee the scrap-pile is so arranged that all scrap material that is to be used in forging is laid out in alleys, in such a way that one class of iron and size of iron is put together, and consequently if there is a piece of scrap iron on hand a blacksmith can find it and get it as readily as he could get a new bar out of the iron house. The blacksmith foreman and iron-house foreman are thus as well acquainted with the iron on hand in the scrap department as they are with the new iron in the storehouse.

Mr. Peck thought that more saving could be effected by watching and preventing the careless scrapping than by working over old scrap. If a shop is equipped with shears, it is all right; but if you have to do the work by hand, as small shops must, it does not pay.

Mr. Hatswell said that on his line old bolts are returned to the scrap department and are then straightened and cut to standard lengths, and are used over again if they are fit for such use. Old nuts he put into a furnace and reheated and then soaked them in oil. He had made taps of case-hardened wrought iron, and run these taps through the old nuts, which made the old nuts as good as new ones. He said further that in one of the shops of their car department between 50 and 60 per cent. of all metal work used is second-hand material, and one shop had used as much as 90 per cent.

All this sounds very much like old-fashioned economy, and as the speaker last quoted remarked, "It seems rather curious that at this late date we begin to find out that a railroad has a scrap-pile." The interesting fact is that it seems as if considerable amounts of money can be saved by the exercise of some diligence and intelligence in the disposal of the contents of what may be regarded as a sort of purgatory of old railroad material.

FUEL CONSUMPTION BY LOCOMOTIVES.

At one of the meetings of the Western Railway Club, from the reports of which we have quoted so liberally in the preceding article, Mr. William Forsyth, of the Chicago, Burlington & Quincy Railroad, read a paper on Locomotive Fuel. In that report he says it was his intention to investigate the progress which has been made in coal burning on locomotives in the past ten years, with respect to boiler construction, fire-box, grate and draft appliances, as well as methods of firing. It was his intention, he says, to compare the work done in hauling trains by one ton of coal in 1883 with the same work in 1893. He was deterred, however, by the fact that the discussion of the composition of coal, which formed the first part of his paper, had already made the paper too long, and that the difficulty of getting exact data for such a comparison is very great, and, in many cases, impossible. His hearers and readers, it is thought, will regret that he did not carry out his intention, and they will entertain the hope that he may be induced at some time in the future to carry out his purpose in that direction. He supplements his paper with a few suggestive statistics, such as a statement of the fact that within the past decade the coal consumption per car per mile on his line of road has increased from 5½ to 6½ lbs., or 18 per cent. No data are given to show the relative average weight of cars now as compared with what it was ten years ago. He shows, however, that the difference in fuel consumption in different classes of engines is very great. Thus 40 Class A 17-in. engines, with 17.6 sq. ft. of grate area and deep fire-boxes between the frames, burned 6.32 lbs. of coal per car per mile in 1893, while 40 Class H mogul engines, with 27.6 sq. ft. of grate area Belpaire boilers, with fire-boxes above the frames, burned only 4.61 lbs. of coal per loaded freight car per mile. No other data about the engines is given, excepting the statement that the H engines are heavier than the others. Fuller dimensions and descriptions of these engines would have been interesting to those not familiar with the equipment of the Chicago, Burlington & Quincy Railroad. Nothing is said either of the relative train loads. It is said though that the difference of fuel consumption in favor of the heavier engines was 37 per cent., from which the inference would be that the train loads were larger with the heavy engines.

Some interesting figures are also given showing the variation between the performance of different engines of the same class in the same service. For the A engines the maximum is 9.66 and the minimum 4.62 lbs. per car per mile, a variation of more than 100 per cent. For the H engines the maximum is 6.81 and the minimum 4.06, a variation of nearly 60 per cent. Their compound H engine burned only 3.27 lbs. per car per mile. In 1883 the average grate area per engine was 16.37 sq. ft., while in 1893 it was 18.95 sq. ft., an increase of 15.7 per cent.; nevertheless the records of the whole road show an increase of 18 per cent. in fuel consumption per car per mile. Not knowing the relative average weight of cars in 1893 and in 1894, of course no inferences can be drawn of the proportionate fuel economy then and now, but these data make it appear somewhat doubtful whether much advance has been made in that direction.

Mr. Forsyth suggests the following lines of inquiry:

1. Are we making any progress in economical coal burning?
2. How can it be most easily and exactly shown from yearly accounts?
3. What is the best method of showing fuel consumption so as to properly grade the performance of the engine-men?
4. Will it pay to keep records in sufficient detail to show what we are actually doing in this direction?

To the latter inquiry we would give an unqualified yes for an answer; but there is room, we think, for doubt about the wisdom of spending much time or thought in ascertaining the relative economy of old and more or less antiquated forms of engines. Of course they should be made to do as good service as they are capable of doing, but the question which most managers are most anxious to know is what kind of engines are the best adapted to and will be the most economical in different kinds of service. Nearly every locomotive superintendent is ready to advocate the merits of *his* "standard" form of engines for the service in which they are employed. Now it would be extremely interesting if once in a decade, or perhaps oftener, a national test of a few of the leading types of locomotives could be made under uniform conditions, in which each could show the best it could do. If any one type of engine possessed marked points of superiority, it would certainly appear in such a test.

NEW PUBLICATIONS.

"New York Railroad Men," a Monthly Publication Devoted to their Interests. Published by the Railroad Branch of the Young Men's Christian Association of New York.

This journal comes to us in a new dress and attractive form. The size is that of the ordinary popular magazine, and the number before us contains 18 pages of excellent reading matter relating to the work of that Association. "Our purpose," the editor says, "is to benefit railroad men by adding to their fund of information, by advocating morality and religion, by

opposing wrongdoing in every form so far as it relates to them; to champion the cause of the Young Men's Christian Association as an agency of proven value in promoting their welfare, and by seeking to exalt manly virtue, faithfulness and intelligence in the performance of duty and true character as the surest way to obtain permanent success." To all of which we say, Amen.

"Locomotive Engineering" (New York) also comes newly clothed. Its pages are now 9 × 12 in., which size is one of the standards proposed for publications by the Master Car Builders' Association. As usual, it is full of illustrations and descriptions of all kinds of appliances relative to railroad and locomotive work.

The Tradesman Annual, No. XVI, containing 218 pages, is filled from one end to the other with contributions from many writers relating to the main industries and chief resources of the Southern States. The number is a sort of encyclopædia of these subjects. It is elaborately illustrated, and contains besides a list of over 5,000 names and addresses of persons, firms and companies engaged in all lines of industries in that section.

Stresses in Girder and Roof Trusses, for both Dead and Live Loads, by Simple Multiplication, with Stress Constants for 100 Cases, for the Use of Civil and Mechanical Engineers, Architects and Draftsmen. By F. R. Johnson, Asso. M. Inst. C. E. London and New York: E. & F. N. Spon, 1894.

This little book contains seven pages of text and 140 pages of tables, the text being hardly as much as a full explanation of the tables. The tables simply give coefficients, which, when multiplied by an assumed unit of load, give the strain in each member for a number of skeleton trusses and skeleton roofs. They would not be applicable to trusses of different proportions, and while they may be very useful to the author, if his practice calls for a repetition of structures of these lines, it is not likely that they would be of much use to any one else. In the present American practice, where the calculation of strains in skeleton structures is well understood, and where the forms of skeletons are constantly varied to adapt them to individual cases, these tables would be practically useless. They may be valuable where material is cheap and designers are without education, but they are not valuable to the educated designer who is studying to economize material.

A Text-Book of Mechanical Engineering. By Wilfrid J. Lineham, head of the Engineering Department at the Goldsmiths' Company's Institute, New Cross, London. Chapman & Hall, Limited. 772 pp., $5\frac{1}{4}$ × 8 in.

At last we have a good book on mechanical engineering, one which can be recommended to students and apprentices with little reserve. Considering how great the interests are which are included under the general heading of Mechanical Engineering, it is surprising that a book of this kind has been so long in appearing. In his preface the author says that his aim was to furnish "a comprehensive work which would at least show students the general lines on which their study as engineer apprentices should proceed." In seeking to do this, he says further, he had "to consider seriously whether the whole theory and practice of mechanical engineering, or even a *précis* of it, could be compressed into one volume, and whether it was desirable so to compress it." He has attempted to do this, and the book therefore covers a very wide field, many portions of which necessarily could not be very thoroughly cultivated. Still it is remarkable that so much could be compressed within the limits of one book, and what is given is excellent. There are no indications of that bane of technical books, "collation"—that is, of a collection and comparison of what has been written by others on the subject, and then making a more or less weak solution by mixture with the author's own views and opinions. The engravings in the book are numbered up to fig. 732, and we have not been able to detect a single instance in which it was apparent that advertising engravings taken from trade catalogues had been made to do double duty by being reprinted in the book before us. The illustrations all appear to have been original drawings, made especially for the purpose for which they have been used. Some of these, however, are not quite up to the standard which might be expected in a book of this kind, written by a professor in a technical school, a special function of which is to teach mechanical drawing. The only harsh criticism for which there is any opportunity is in relation to some of the illustrations. Some of these—particularly in the beginning of the book—appear to have been made by immature students, and besides this defect, they are execrably engraved, for which, in these days of cheap "process" work, there is no excuse. Both the drawings and the engravings improve as the pages advance; and it appears as though the draftsman who made them had been gaining in skill and practice in doing the work for the author. In his preface he takes especial occasion to thank the firm who made the "bulk of the zincographic blocks" for the reproduction of the drawings. A little vituperation might with justice have been added to this commendation. If the engravings on pages 8, 9, 16, 35 and 73 are deserving of praise, the art must be at a very low ebb in England.

The reviewer having allowed the wrath of a mechanical draftsman to vent itself, now finds occasion only for commendation of the book. It is divided into two main parts, the first relating to Workshop Practice and the second to Theory and Examples. The first contains chapters on the following subjects: Casting and Moulding; Pattern-Making and Casting Design; Metallurgy and Properties of Materials; Smithing and Forging; Machine Tools; Marking-off, Machining, Fitting and Erecting; Boiler-Making and Plate Work. The second part, in separate chapters, treats of Strength of Materials, Structures and Machine Parts; On Energy, and the Transmission of Power to Machines; On Heat and Heat Engines; Hydraulics and Hydraulic Machines.

In the space and the time which is available a review of this book is very difficult, and must be very inadequate. The author's method of treatment of the subjects he discusses can be shown by summarizing the first chapter on Casting and Moulding. In this he begins by describing cast iron and its characteristics, chemical composition, and the method of melting it, with a description and engravings of a cupola. After some general observations on moulding, moulding-boxes—or "flasks," as they are called in this country—are described. Moulding sand and its different qualities and uses are explained, and the general methods of moulding in loam, open sand, and with patterns and moulding-boxes of various kinds are fully illustrated and described in the most admirably clear way. The illustrations—excepting their graphic execution—are excellently suited to illustrate the subjects they are intended to elucidate. The objects which are selected for the purpose of explaining how they are moulded are a cattle-trough, a hand-wheel, a chain-pulley, a worm-wheel, a drilling-machine table, a cylinder head or cover, a traction engine road wheel, a gas-pipe main and bend, a steam cylinder with its cores and core-boxes, a screw propeller, a fly-wheel, an air vessel, cone pulley, stop-valve, and plummer block. Sectional views of these are shown in the sand, and illustrations are given of the cores and core-boxes, the method of parting of the flasks, and of striking or sweeping moulds for a steam cylinder cast in loam. The appliances used are shown in great detail, and the explanations are excellent. Illustrations are also given of a wheel-moulding machine, and the methods of moulding wheels with such machines are described. The process of making chilled castings is illustrated by sectional views of a cast iron car wheel and a chilled shot shown in the sand. The method of making and annealing malleable castings is described, and the construction of an annealing furnace is illustrated with an engraving. Brass founding is treated in a similar way, and descriptions and observations are given with reference to the construction of "gates," cores, and moulders' tools. The chapter ends with some descriptions of mixtures of cast iron and observations on steel castings. It contains in all 52 engravings, which are admirably designed for illustrating the subjects to which they relate; but, as remarked before, some of them are execrably engraved.

The subject of pattern-making is treated in a similar way, and contains 31 engravings.

In the third chapter the characteristics of various kinds of metals and the method of their manufacture are very concisely described.

The chapter on Smithing and Forging occupies 49 pages and contains 37 figures, many of them with a half dozen or more separate details. Folded plates are also given showing arrangement of a "smithy," views of a steam hammer, and an excellent "Tempering Table" printed in colors, and showing the tints to which steel should be heated to produce different degrees of temper or hardness. The methods, tools and appliances which are used for producing forgings of different kinds are discussed in great detail but in a condensed and concise way, so that the reader is never wearied by iteration.

Chapter V, on Machine Tools, as might be expected, is a long one, and occupies 46 pages and contains 62 engravings, among them large folded plates of several kinds of lathes, a boring, a drilling, a planing, a shaping, a slotting and a milling machine. The uses of these machines are very fully described.

Chapter VI, on Marking-off, Machining, Fitting and Erecting is equally full and complete, and illustrations and descriptions of all the well-known shop tools, and of many that are not well known, are given, and their use is fully described. It should perhaps be explained that the illustrations of these tools and machines do not represent conventional appliances of a more or less antiquated design, but they are obviously made from appliances in actual use, which are generally of the most approved and latest design. The remarks apply also to the chapter on Boiler Making and Plate Works, in which some processes, machines, tools, and appliances are described which will probably be new to many American mechanics; and there is probably no chapter in the book which they can read to as much advantage as this one. The illustrations and descriptions of hydraulic machine tools for boiler work (Plates XV and XVI), and also the hydraulic flanging machine (figs. 289 and 290), will be of especial interest to many American readers. Other hydraulic machines and tools are described, and the comparative speed and cost of hand and machine riveting are discussed and illustrated by diagrams; electric welding is also given a place in this chapter; and the "geometry required by the boiler maker" is described, and the methods of laying off plates for boilers is explained. This chapter ends Part I, and up to this point little or no mathematics will be found in the different explanations.

In Part II, on Theory and Examples, mathematics are freely used. Many readers will be in full sympathy with the author when he says—as he does in the preface--that while he has never introduced mathematics unnecessarily, when he has he has "stated all the 'steps' that space permitted in such mathematics as have been introduced, and the latter will be found of but an elementary character, involving only simple equations, fractions, and the use of tables of sines and logarithms."

Part II opens with a Synopsis of Lettering adopted in this Part. This gives a list of letters or mathematical symbols and what they are used to represent, which will save the reader much perplexity in studying and applying the formulæ which are so liberally used in the second part of the book.

In a notice of this kind but little can be done but to speak in a general way of the treatment of the subjects which the author has attempted to elucidate. The deficiency which the general reader will encounter in this part is that the subjects discussed are not sufficiently explained. This will be particularly the case with readers who are poorly equipped by previous technical training and education to comprehend explanations which are necessarily condensed into a form which will often approximate to a condition of incomprehensibility. A mere enumeration of the subjects which are elucidated in the second part of this book would probably occupy a whole page of the American Engineer, if set in closely printed type. Necessarily but little space could be given to each. Thus, the Strength and Testing of Materials; Testing Machines; Stress-strain Diagrams; Strength of Chains; Ropes, Pipes, Cylinders, Fly-wheels, Bolts, Links, Riveted Joints, Pins and Bolts, Colter Joints, Solid and Hollow Shafts, Couplings, Coupling Keys, and Springs; Theory and Strength of Beams of different kinds, Axles, Crane Hooks, etc., Columns, Connecting-Rods, Furnace Tubes and Crank-Axles; Theory of Braced and Framed Structures, including Roof Trusses, Suspension Bridge Chains, Warren Girder, Jib Cranes and Wind Pressures are all discussed in Chapter VIII, which contains 112 pages. Naturally the explanations and treatment of these subjects are more or less inadequate, and the reader who goes to the book for the elements of the subjects discussed will have much difficulty in comprehending what the author has attempted to teach. It is remarkable, though, how much he has managed to condense into his pages. The eighth chapter, on Heat and Heat Engines, which contains 130 pages, is remarkable in this respect. It ranges over the whole field comprehended by that title, including the Theory of Heat; Pyrometers; Thermodynamics; Losses in Steam Engines; Cylinder Condensation and Re-evaporation; Theory of Compounding; Steam Engine Indicator; Topography of Indicator Diagrams; Single, Double and Triple Expansion; Combination Diagrams; Various Forms of Steam Engines; Slide-Valves; Relation of Crank and Eccentric; Reversing Gear; Valve Gears; Governors; Variable Expansion Gear; Marine Governors; Zenner's Valve Diagram; Ideal Diagrams for Compound Engines; Correction of Indicator Diagram for Inertia; Curves of Crank Effort; Weight of Fly-Wheels; Pumping Engines; Triple-Expansion Marine Engines; Locomotives, including Springs, Brake, Boiler, Traction Force, Safety Valves, Gauges, Injectors, and Forced Draft, Gas and Oil Engines.

The treatment of all of these subjects is admirable, but necessarily condensed to a form resembling the "pocket-book" style of treatment. As an example of the author's style we will give what he says under the head of the Losses in Steam Engines. These, he says, are:

1. Steam is not supplied at the temperature of the hot body (furnace).
2. Steam is not rejected at the condenser temperature and pressure, but falls as regards both when leaving the cylinder.
3 The feed-water has its temperature raised in the boiler instead of being originally at the temperature of the steam.
4. The expansion should be adiabatic, as in a non-conducting cylinder, but it varies considerably from this.
5. The steam should be compressed from condenser temperature to boiler temperature. It is, however, only compressed through a portion of this rise, the rest being obtained by heat supply from the boiler.
6. Clearance in cylinder being unavoidable, must be filled by steam at each stroke, which does no work during "full-pressure" period.
7. The boiler "primes" more or less—that is, sends water particles to the cylinder along with the steam, which pass to the condenser without doing work, or, still worse, abstract heat from the cylinder steam in their endeavor to vaporize.
8. The limits of working temperature are small in comparison with the temperatures themselves; *r tan.* 1 being fixed to prevent burning of cylinder oils and packing, and *r tan.* 2 by the cold well temperature.
9. Work is lost in (*a*) the "solid" friction of the engine parts, (*b*) the fluid friction of the passing steam.

A chapter on Hydraulics and Hydraulic Machinery and a good index completes the book, which can be highly commended, with the reservation that the young student and apprentice without an instructor will probably often be puzzled to comprehend the condensed and somewhat inadequate explanations.

Theory and Construction of a Rational Heat Motor. By Rudolf Diesel. Translated by Bryan Donkin, M. Inst. C.E. London: E. & F. N. Spon; New York: Spon & Chamberlain.

The author of this little book of 85 pages is the inventor of a heat motor which promises to be to the gas engine what Watt's steam engine was to the atmospheric engine.

The fundamental invention of Watt consisted in the addition of a separate condenser, thereby avoiding the enormous waste of heat occasioned by the alternate heating and cooling of the cylinder which occurred in the atmospheric engine. Mr. Diesel's invention does away with the water-jacket that carries away from a third to a half of the heat generated in the cylinder of an internal combustion engine.

The method and the efficacy of Mr. Diesel's invention can be best shown after the consideration of the action of a gas engine like the Otto engine. This engine draws in an explosive mixture of air and gas during the filling stroke, and on the return stroke compresses it to about 50 lbs. above the atmosphere. The charge is then ignited and explodes nearly instantaneously, and the pressure rises rapidly to about 200 lbs. above the atmosphere, and the temperature becomes about 1,600° C. The piston then makes the motor stroke, and the gas expands to about 20 lbs. above the atmosphere at release. Owing to the phenomenon known as after-burning, the gas remains at a high temperature throughout the expansion, and flame often flashes into the exhaust-pipe. Water is circulated through the water-jacket to prevent the temperature of the cylinder walls from rising too high. The expansion curve very nearly coincides with the adiabatic line for a perfect gas, which shows that the heat carried away by the water-jacket is nearly the same as that generated by the after-burning.

Let us consider that form of Mr. Diesel's motor which most nearly resembles the Otto engine. It is interesting to know that an engine of this type, to indicate 15 H.P. at 300 revolutions per minute, is now undergoing test in Germany. This engine draws in atmospheric air and compresses it to 90 atmospheres then by raising the temperature from 20° to 800° C., which corresponds to a red heat. The pressure of 90 atmospheres is, roughly, 1,300 lbs. above the atmosphere, a pressure seven or eight times as high as that commonly used with steam engines. The high pressures required for the proper action of Mr. Diesel's motors will probably give trouble in the development for commercial purposes; but as the pressures are developed gradually, and do not occasion shocks, he thinks that they will present no insuperable obstacle. Fuel in a finely divided state is fed into the cylinder during about one-tenth of the motor stroke, and burns instantly in the hot air. The admission should be so regulated that the temperature shall remain at 800° C., making this part of the expansion line an isothermal. The method of regulating the supply of fuel will probably be worked out experimentally; at any rate, the details are not clearly explained in the book. After the admission of fuel ceases the expansion is nearly adiabatic, and gives at the end of the stroke a pressure of about 9 lbs. above the atmosphere and a temperature of 187° C.

The theoretical efficiency of this cycle is 65.4 per cent, which corresponds to something more than a quarter of a pound of coal per H.P. per hour. If we add half again as much to allow for imperfections, we shall have $\frac{4}{10}$ lb. per H.P. per hour—a sufficiently brilliant result.

A more complete and also a more complicated form of motor, which will be referred to later, has an efficiency of 73 per cent., which corresponds to just ¼ lb. of coal per H.P. per hour. This is considered to be ten times the efficiency of the best steam engine, so that the author hopes for five or six times as good results as one obtained by steam engines. But steam engines have shown an actual efficiency of 18 or 19 per cent., using about 1¼ lbs. of coal an hour. But an inventor who can reduce coal consumption to one-third will have abundant success and fame.

Mr. Diesel finds that by closing the admission-valve at three-fourths of the filling stroke, and allowing an idle expansion to the end of the stroke, and so starting the compression from the atmospheric pressure at one-fourth of the return stroke, he can carry the expansion during the motor stroke down to the atmospheric pressure. The gain in efficiency by this device is only 2.4 per cent., and is properly considered not worth while.

Mr. Diesel has also worked out a cycle, and has devised the mechanism for an engine to give a theoretical efficiency equal to that of Carnot's cycle. His mechanism uses two single-acting pistons, or rather plungers, and a larger double-acting piston, which acts as an air-compressor on one side and an expander on the other side. The mechanical arrangements are not complicated, and seem to have been carefully worked out. An intelligible description is, however, beyond the limits of a review. It may, however, be interesting to note some of the main features. They involve an isothermal compression to nearly three atmospheres by the aid of water injected into the air compressor; while an isothermal compression cannot be attained by this means, the air can unquestionably be brought to the temperature of the atmosphere after compression. Then there is an adiabatic compression to 800° C. and to 250 atmospheres, which is, roughly, 3,600 lbs. above the atmosphere, a pressure which it may be hard to obtain in an engine, and harder yet to use. This compression takes place above one of the plungers, which on the next down stroke provides for the isothermal expansion, during which fuel is admitted, and for an adiabatic expansion to four or five atmospheres. The air is then transposed to the top of the large cylinder and expanded down to atmospheric pressure. The two plungers which rise and fall together make one motor stroke out of four, while the expander acts on each down stroke and serves for completing the expansion for both plungers.

The valve mechanism involves the use of cams making 150 revolutions per minute, which may lead to practical trouble or annoyance. The inventor also introduces helical gears where modern-cut bevel gears would probably do better.

A very complete series of mechanisms are arranged for feeding fuel in various states—solid, liquid, and gaseous—but the regulation of the supply during admission does not appear to be shown by the book, as has already been said. There can be no difficulty in the use of gas introduced in fine streams into hot air. Liquid fuel, like petroleum, which is used in the experimental engine, can cause little trouble unless the flame may deposit carbon on the walls of the cylinder. The inventor naturally desires to use solid fuel, as being the cheapest. He shows how finely powdered coal may be introduced at the proper time. As only a small quantity of coal is introduced at a time, and as the ash remaining after combustion will be but a fraction of the coal, he concludes that it will be swept away by the air, and will make no trouble. He, however, suggests that the coal may be crudely burned to gas if necessary. He does not, however, seem to consider the difficulty of compressing this gas, already at a high temperature, without first cooling it.

To make a brief review intelligible, we have begun with the description of his engine, which forms the second chapter of the book, and have considered first his crudest form of engine, which he describes last of all. In a manner we have worked backward through the second half of the book.

The first chapter takes up the thermodynamic theory of internal combustion engines of several types, including engines in which the combustion is at constant pressure, as in the Brayton engine, engines in which the combustion is at constant volume, as in the Otto engine, and finally his own type of engine, in which the combustion is at constant temperature. This work is thorough and logical—too much so, perhaps, as it appears to run into unnecessary refinement and tedious details. And yet, as only the theory of perfect gases is used, it is neither long nor difficult.

The author shows that the application of a regenerator to an internal combustion engine is undesirable. He assumes that it is used to heat the charge of air drawn in during the filling stroke of the compressor, which is truly the only place where it can be used; he appears to conclude that the principle of the regenerator is wrong instead of recognizing that it cannot be applied at the right part of the cycle with three engines. A correct statement of the effect of heating the charge is given by Mr. Dugald Clark in his work, "The Gas Engine," published in 1886. There can be no question in the mind of any one who is familiar with the action of closed cycle hot-air engines, like the Stirling engine, that a regenerator is required if any amount of power is desired, not to say anything about efficiency; and it is for these engines that the theory of the regenerator is discussed by Rankine and Zeuner.

The translation by Mr. Bryan Donkin is admirable. He is to be congratulated that in a work of this sort the typographical errors are so few and so unimportant.

On the Development and Transmission of Power from General Stations. By William Cawthorne Unwin. London and New York: Longmans, Green & Co. 312 pp., 5½ × 8⅝ in.

This treatise, the author says, is based on a course of lectures delivered at the Society of Arts in 1893. Their general construction in a measure indicates this, as the different chapters are made up into convenient lengths for lectures, and have a sort of class-room flavor which it would be difficult to describe with precision, but is easily recognizable. It results, probably, from the fact that few authors who intend to deliver orally what they write can divest themselves entirely of a consciousness of that purpose, and so their writing in some way shapes itself into that final form or style. Of course this has little or nothing to do with the intrinsic value of the lectures or of the book. This is determined by other considerations.

The titles of the chapters will indicate the subjects treated better perhaps than anything else which can be said. These are: I, The Conditions in which a System of Distribution of Energy is Required, and General Considerations on the Sources of Energy; II, Power Generated by Steam Engines, Conditions of Economy, and Waste; III, The Cost of Steam Power; IV, The Storage of Energy; V, Water Power; VI, Hydraulic Motors; VII, Telodynamic Transmission; VIII, Hydraulic Transmission; IX, Transmission of Power by Compressed Air; X, Calculation of a Compressed Air Transmission when the Subsidiary Losses of Energy are Taken into Account; XI, Distribution of Power by Steam; XII, Distribution of Gas for Power Purposes; XIII, Electrical Transmission of Power; XIV, Examples of Power Transmission by Electrical Methods; XV, The Utilization of Niagara Falls.

In the opening chapter the author says: "The special problems to be dealt with are the conditions which favor the production of a convenient form of energy on a large scale and in the most economical way; the means of conveying it to a distance and distributing it to consumers; the arrangements for measuring the quantity delivered; and lastly, the relative advantages and disadvantages of a system in which the energy is obtained on a large scale and distributed to many consumers, compared with a system in which each consumer produces the power he requires in his own locality and under his own supervision and responsibility."

In the chapter on Steam Engines, the fact that small engines are costly, uneconomical and inconvenient, and also that when the load of large engines is varying and intermittent, the conditions are not favorable to economy, is stated, and in what follows the cases are examined in detail and the causes of waste are traced to their source.

From a table of carefully selected steam engine trials the following conclusions are drawn:

"The steam consumption and fuel consumption are less for large engines than for small engines; less for quick than for slow engines; and for suitable pressures, less for compound and triple than for simple engines. Two special groups of tests have been selected to show the economy due to jacketing and the economy due to the use of superheated steam." With reference to the latter, the author says: "Lately superheating has been re-introduced in Alsace, where its advantages were first discovered, and superheaters have been applied to a large number of boilers. Many experiments have been made by Alsatian engineers with saturated and superheated steam in the same engines. In all cases they have found an economy ranging from 10 to 25 per cent. when superheated steam was used. It has been commonly alleged that the high temperature of superheated steam causes scoring or erosion of the cylinder and valve faces. Such injury did occur in the early use of superheated steam, for at that time no lubricant was obtainable capable of standing a high temperature. But this danger has probably been very greatly exaggerated. The cooling action of the cylinder is so great that superheated steam does not retain its high temperature for a sensible time after admission. With ordinary care and the use of a good lubricant it does not appear that the engines using superheated steam suffer any injury." In some experiments which the au-

thor made to test the relative economy of an engine working with saturated and superheated steam, he found an economy of 17.6 and 20.1 per cent. from the use of the latter. On another page we give an engraving and description of a boiler for producing superheated steam, and which has shown some remarkable economies.

The general plan upon which the book is constructed is to describe methods of distributing power, then give a succinct explanation of the theory on which they act, and a general statement of the cost and conditions under which they can advantageously be used. The description of various "installations" for the distribution of power by various systems is admirable; and nowhere else can an engineer learn so easily what has been done in actually using the various systems as he can from the book before us.

The author is loud in his praises of the advantages of distributing power by compressed air. Of the use of this method in towns, he says it has the following desiderata:

"1. The possibility of indefinitely subdividing the power distributed and measuring the supply to each consumer.

"2. Minimum first cost of distributing mains and minimum loss of energy in distribution.

"3. Simplicity, cheapness, and efficiency of the motors required by consumers of power, and especially that the motors should require little attendance and involve little risk.

"4. Freedom from danger to life or property when accidents occur to motors or distributing mains.

"5. Facility of adaptation to various requirements additional to the supply of motive power.

"The air motors are generally of a very simple kind, and are very convenient. They can be started at any moment; they are free from inconvenience, from leakage, heat or smell, and they require a minimum of attendance. Often the exhaust can be used to cool and ventilate the working rooms. The air motors are used for various purposes. At some of the theatres and restaurants they drive dynamos for electric lighting. At some of the newspaper offices there are motors of 50 and 100 H.P., driving printing machines. In workshops there are motors driving lathes, saws, polishing, grinding, sewing, and other machines. At the Bourse de Commerce the compressed air drives dynamos for electric lighting, and also is used to produce cold in large refrigerating stores. In many of the restaurants air is used for cooling purposes. It is also used to work cranes and lifts directly, a water cushion being used between the working cylinder and the lift."

Probably many readers of this book will be as much struck with the low estimate of the value which the author seems to place on the system of electrical transmission of power as they are with the high valuation with which he regards pneumatic transmission.

Of the former system he says: "Having regard only to plants actually at work, it must be confessed that the total amount of power transmitted electrically and used for industrial purposes, exclusive of traction, is not yet very great. . . . If electrical transmission is to be extensively used, it must be when it can be carried out so cheaply that power can be supplied at a less cost than that at which consumers can produce it for themselves. . . . The ordinary price of electricity for lighting purposes is 6 *d.* per unit, which is equivalent to about £60 per H.P. per year of 3,000 hours. At that price it can only be used for power purposes either when the power is required for short periods intermittently or where there is great local inconvenience in employing steam or gas engines. It is only where electricity costs from one-sixth to one tenth of its ordinary price when used for lighting that it can have any large importance as a means of obtaining power."

He then concludes that systems for distributing motive power electrically have the following limitations:

"(*a*) When the power is initially steam power, its distribution electrically adds so much to its cost as to prohibit its transmission to any great distance in nearly all cases.

"(*b*) Hitherto it has only been in districts where cheap overhead conductors carrying high-pressure currents can be safely used that electrical methods of transmission have proved commercially successful."

In the chapter on the Storage of Energy, a brief description is given of the system of thermal storage proposed by Mr. Druitt Halpine. His plan is to communicate heat to water in boilers, and then store the water thus heated to a high temperature in tanks or reservoirs, which are of course properly protected from a loss of heat from radiation. From the reservoirs steam is taken through a pressure-reducing valve exactly when and in what quantity it is required. Very favorable reports of this system have been made, and it seems to be gaining in favor very rapidly in Europe, where it is now in use. It would have added very much to the interest of Mr. Unwin's book if he had given a fuller description of this system. But without this the book is a very valuable contribution to the branch of engineering science to which it relates, and it occupies a place which no other treatise does.

BOOKS RECEIVED.

Memoranda Regarding Rapid Transit Routes. By J. J. R. Croes.

The Aeronautical Annual, 1895. Edited by James Means. Boston: W. B. Clarke & Co.

The Steel Construction of Buildings. By C. T. Purdy, C.E., Bulletin of the University of Wisconsin.

Practice and Theory of the Injector. By Strickland L. Kneass, C.E. New York: John Wiley & Sons.

The Evolution of a Switchboard. By Arthur Vaughan Abbott, C.E., Bulletin of the University of Wisconsin.

Notes on the Year's Naval Progress. Navy Department, Office of Naval Intelligence. Washington: Government Printing Office.

Proceedings of the International Electrical Congress. Held in the city of Chicago, August 21–25, 1893. New York: Published by the American Institute of Electrical Engineers.

Practical Application of the Indicator, with Reference to the adjustment of Valve-gear on all Styles of Engines. By Lewis M. Ellison. Published by the Author, 25 Lake Street, Chicago.

TRADE CATALOGUES.

Graphite as a Lubricant, Scientifically and Practically Considered; also its Value as an Accessory for Engineers and Machinists. Third edition, revised. Joseph Dixon Crucible Company, Jersey City, N. J. 20 pp., $5\frac{1}{4} \times 6\frac{3}{4}$ in.

This is a new edition of a publication already noticed in our columns. It tells all about "Graphite as a Lubricant," with reports and testimonials as to its value for that purpose.

The Venturi Metre. Builders' Iron Foundry, Providence, R. I.

This company have issued a new edition of a pamphlet describing this ingenious machine, which is patented by Mr. Clemens Herschel, and is manufactured by the Builders' Iron Foundry. In this new pamphlet the construction of the metre is described more fully, and different applications of it are described which add to the interest of the publication.

Catalogue of Machine Tools, made by the Cady Manufacturing Company, Cleveland, O. 24 pp., $3\frac{3}{8} \times 6\frac{1}{4}$ in.

The class of tools which this Company manufacture are drop-hammers, power presses of various kinds, punches and shears combined, automatic, rotary and semi-automatic wire straighteners and cutters, and other wire-working and sheet-metal machinery, and also portable forges, emery grinders, drilling machines and screw presses. Many of them are illustrated by good wood-engravings with brief descriptions.

Catalogue "M," Bundy Radiators for Steam and Hot Water, also Heating Specialties Manufactured Exclusively by A. A. Griffing Iron Company. New York. 176 pp., $8\frac{1}{4} \times 5\frac{1}{4}$ in.

This book contains what its title indicates—that is, illustrations of heating apparatus, among them a number of new features, but which are hardly included within our specialty of mechanical engineering. The book is for steam-fitters, engineers, architects, and dealers in that kind of "goods."

Calendars.

Of these reminders of one's mortality we have received a number. One from the Buffalo Metre Company illustrates the meter which they make, and which measures water and not time. The card on which the calendar is mounted also has an engraving showing a bird's-eye view of Niagara Falls and a sectional view of the power tunnel. The Lawrence Cement Company, of New York, have sent us another calendar with a very effective engraving of a lion, we suppose to symbollize the strength of their cement. It does not seem quite sure that the lion is in this case the correct emblem—lions are strong to rend asunder, not to hold together. A gigantic leech, a life-insurance agent, or a poor relation have more capacity for holding on than a lion has. The New York Dredging Company also remind us of the flight of time by a calendar on which they have illustrated one of their dredges discharging through 5,700 ft. of pipe. *Tempus fugit.*

Illustrated Catalogue, No. 19, of Steam Pumping Machinery, Manufactured by Dean Brothers' Steam Pump Works, Indianapolis, Ind. 134 pp., 6 × 7½ in.

Messrs. Dean Brothers have here availed themselves of all the most recent modern means of publishing a book of this kind in the way of good paper, typography and engraving. The frontispiece is a view of their extensive new works, which have recently been occupied, and on the opposite page is an excellent interior view of their machine shop. Following this is a sort of sectional diagrammatic view of one of the Dean pumps, showing the construction and peculiarities of its valve gear. A very good description of it is given on the opposite page. After this an excellent view of a boiler-feeder, followed by directions "how to order pumps," which ends with the injunction, "Be sure to order a pump large enough for the service intended. Many make the mistake of ordering pumps too small. A slow piston speed is desirable, especially when pumping against heavy pressure."

The illustrations which succeed this are most of them very good half-tone engravings, representing pumps which might be used for pumping any conceivable liquid, from earth oil to the nectar of the gods. There are boiler-feeders, tanks, double plunger, fire, low-pressure, ball-valve, vertical, upright, deep-well and mine, sinking, brewers', air, duplex fly-wheel, distillery, rectifiers', power, geared, natural-gas, pneumatic lift, air compressor, crank, fly-wheel, artesian well, vacuum, and air pumps, with condensers, ammonia and duplex pumps of various kinds. The book ends with directions for setting up and running pumps, hints on hydraulics, boiler-supply, a table to show the equivalent pressure due to columns of water from 10 to 400 ft. in height. Also the number of gallons of water delivered and the height to which it will be projected through nozzles from ¼ in. to 2 in. diameter, a table showing the capacity of pumps at 100 ft. of piston speed and another showing the strokes required to reach a piston speed of 100 ft. per minute. A table of areas of circles, and another giving the percentage of saving of fuel by heating feed water with steam at 60 lbs. This latter is interesting, and is reproduced here. It is well worth study by steam users:

coated paper, luxurious printing and binding, it is difficult to find words which will adequately describe some of the publications of this kind which are now being issued. The one before us is an example. We must begin, however, with a little animadversion. The lithographed title-page is hardly up to the standard and style of the rest of the book.

The first illustrations after the title-page are two interior views of the director's car, *The Nomad*, for the Rio Grande Western. These views—and nearly all the other engravings—are half-tone engravings, made from excellent photographs, and those referred to represent an elegant interior. An outside view of the car, which is 65 ft. long over the body, is given on the following page, and is also an admirable illustration. A view of a six-wheeled truck and a telescope-plate comes next. There is no printed description of any kind in the book, the engravings being printed on one side of the leaves only. Some explanation of the uses of "the telescope-plate" would be desirable.

There are also some admirable views of the interior and also of the exterior, and a plan of a "*café* car" for the Wabash Railroad. We must retract, though, about the plan—*it* is not admirable, but must have been made by some 'prentice draftsman, and as a specimen of the draftsman's art is bad, as are the other similar plans in the book. Views, both interior and exterior, of a parlor car, also for the Wabash Road, follow, which are excellent. Then we have interior views of a chair car for the Missouri Pacific Road, without the chairs—that is, the photographs were made before the chairs were put in. An exterior view (good) and a plan (bad) follow. Similar views of a Pacific Road coach are also given. Without enumerating the roads for which they were built, it may be said that there are views of a passenger and baggage, a baggage, mail and express, a mail and a baggage and an express car. Some excellent views are also given showing the system of framing which the Company uses for passenger cars. These represent it as seen from the outside and inside before the framing was covered. There are also views of "museum cars" and an advertising car, which incline one to smile. Views from photographs of excursion, street, motor, electric,

PERCENTAGE OF SAVING OF FUEL BY HEATING FEED WATER (STEAM AT 60 LBS.)

Final Temperature.	Initial Temperature of Water.											
	32°	40°	50°	60°	70°	80°	90°	100°	120°	140°	160°	180°
60°	2.39	1.71	0.86	...		....	....	....	....	....	....	....
80°	4.09	3 43	2.59	1.74	0.88	...	....	....	....	....	....	....
100°	5.79	5.14	4.32	3.49	2.64	1.77	0.90	....	....	....	....	....
120°	7 50	6.85	6.04	5.23	4.40	3.55	2.68	1.80	....	....	....	....
140°	9.20	8.57	7.77	6.97	6.15	5.32	4.47	3.61	1.84	.	....	....
160°	10.90	10.28	9.50	8 72	7.91	7.09	6.26	5.42	3.67	1.87	....	....
180°	12.60	12.00	11.23	10.46	9.68	8.87	8.06	7 23	5.52	3.75	1.91	....
200°	14.30	13.71	13.00	12.20	11.43	10.65	9.85	9.03	7.36	5.62	3.82	1.96
220°	16 00	15.42	14.70	14.00	13.19	12.33	11.64	10.84	9.20	7.50	5.73	3.93
240°	17.79	17.13	16.42	15.69	14.96	14.20	13.43	12.65	11.05	9.37	7.64	5.90
260°	19.40	18.85	18.15	17.44	16.71	15.07	15.22	14.45	11.88	11.24	9.56	7.86

Stow Manufacturing Company, Inventors and Manufacturers of the Stow Flexible Shaft, Binghamton, N. Y. 32 pp., 6 × 8¾ in.

The Stow flexible shaft is so well known by all mechanical engineers and the victims of dentists' chairs that it requires no description. The company which are the chief manufacturers of it have issued a new catalogue (No. 5), showing not only the well-known appliances, but some new ones. Besides the shafts themselves and their immediate connections, this company also makes what may be called collateral tools and appliances which are used in connection with the flexible shafts. These include breast drills, portable screw feed drill presses, pedestal drills, universal joints (for the shafts), drill rests and supports, tapping and reaming machines, ring grinders, counter shafts, lathe centre grinders, portable emery grinders (operated by flexible shafts), stop clutches, which permit the working tool to be stopped and started at will without stopping the motion of the shaft itself, combined flexible shaft and electrical motor, radial flexible drilling, stone grinding and polishing, and boring machines, transfer pulleys, etc.

The company reports that "the last few months have shown a steady, healthy growth, and they expect to do a very satisfactory business in 1895."

Catalogue of St. Charles Car Company, St. Charles, Mo. 112 pp., 10 × 13¼ in.

In reviewing trade catalogues, a reviewer is apt to run out of superlatives. What with photography, half-tone engravings,

refrigerator, caboose, box, stock, flat, coal, dump, drop-bottom, hand, push, logging, side-dump and furniture cars fill the remainder of the book. The illustrations are, some of them, of superlative excellence, and excepting the plans are all good. They are printed on heavy coated paper, and are all well printed.

There is only one serious fault to be found with the book: it has cost so much that the St. Charles Company have felt obliged to discontinue their advertisement, temporarily, in this and other papers. All that is left us is the hope that orders and profits will come to the Company like a flood, and that the newspapers will then get a share of the latter.

NOTES AND NEWS.

An Automatic Steersman.—An automatic helmsman, or application of electricity to the direction of the course of a vessel, is described in a French electrical journal. It is to be operated by an attachment to the compass. The errors in manual steering are stated to be seldom less than 1° or 2°, corresponding with an error of nearly 12 miles laterally in a day's sailing. With the automatic method greater accuracy is said to be possible. The standard compass is used, and a current from a Ruhmkorff coil is passed from the pivot of the needle to the north pole extremity, whence sparks of three millimeters length pass to one of two semicircular pieces of aluminum, insulated from each other, the gap between them being set to the desired sailing direction. When the spark passes to one of these the

current, by means of a relay, starts a motor in one direction, which in turn operates the rudder, while if the spark passes to the other piece, it moves the rudder in the other direction. The apparatus has been in use for two months on a steamer, and it operated very successfully. An additional device is mentioned in which the record is automatically kept.

Preservation of a Vessel with Crude Oil.—A singular process is being attempted at Camden, Me., to preserve the wood of a new 1,400-ton schooner, now almost ready for launching for Amos Burdsall, of Toms River, N. J., and some Philadelphia owners. All of the timber on the inside and outside of the vessel has been soaked in crude petroleum to save it from dry rot by exposure to the air and to prevent the ravages of the teredo worm in salt waters. Even the vessel's beams have been coated and the tips of the topmasts. It is expected that the oil will become so thoroughly soaked in the schooner's upper works that the water cannot penetrate through the wood, and thus it will prevent the rotting of the masts and prolong the life of the vessel. This is believed to be the first trial ever made to preserve a wooden vessel in this manner. Old wooden vessels, which have been converted into bulk petroleum carriers after having outlived their usefulness in other trades, have been known to last for years after becoming soaked with either crude or refined oil.

A New Gun.—The very heavy cost of modern guns is largely due to the time and labor which are necessarily expended upon the operation of rifling them. The material itself is relatively cheap; and a rifled gun, besides being much more costly, is, other things being equal, more short-lived than a smooth bore. It is almost impossible so to make the gun and the projectile that the soft driving bands of the latter shall, at the moment of discharge, accurately fit into the grooves and lands of the bore, and allow no gases to pass ahead. When these gases do pass ahead of the projectile they score and damage the interior of the gun; and, where the new powders are used and the gases of combustion attain an enormous degree of heat, the process of deterioration, especially in weapons of large calibre, is often very rapid. A Swedish engineer, Mr. W. T. Unge, has devised a method whereby he hopes to save, not only the cost of rifling, but also the interior wear and tear for which rifling is responsible. He proposes to construct all guns as smooth bores, and to fit the projectiles with gas checks which shall render it practically impossible for any gases to rush past them. In order to convey to the projectile an axial rotary motion, such as is at present conveyed to it by the action of the rifling, he has invented a mechanical arrangement which, at the instant of firing, gives to the gun itself an axial rotary motion. This may be either constant or increased. He has satisfied himself that the effect upon the projectile is exactly the same as is produced by the constant or increasing twist of an ordinary rifled gun; and he is of opinion that the adoption of his system, while giving equal or even improved accuracy of fire, will reduce the cost of heavy guns by one-half and add fully 100 per cent. to their endurance.—*The London Times.*

RÉSUMÉ OF THE ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN FOR THE YEAR 1894.

In our issue for April, 1893, we began the publication of a brief *résumé* of the accidents on the railroads of the United States that resulted in the death or injury to the men on the engine. As we have repeated with each issue, the only or chief source of information which we have is the newspapers, and this information is necessarily inaccurate in many instances, and incomplete when taken as a whole. As we have also said, the publication is made with the "hope that it will in time indicate some of the causes of accidents of this kind and help to lessen the awful amount of suffering due directly and indirectly to them."

In April, 1894, at the end of the first year of the publication of these accidents, we printed a short *résumé* of those that had occurred during the preceding 12 months, and attempted to point out some of the causes that had given rise to them and to roughly locate the responsibility. In taking up the lists that we have published during the 12 months ending with December 31, 1894, which laps back over some of the months included in the last *résumé*, we find that there has been a very decided falling off in the total, but this does not necessarily mean that the average number of accidents per train mile has fallen off, for there is no doubt but that the falling off in the traffic that all the roads of the country have experienced during the past year is responsible for some of the improvement that appears on the surface of the reports. Upon examination we find that during 1894, 134 engineers and 103 firemen were killed, and that 220 engineers and 176 firemen were injured in the 399 accidents that have happened. By referring to the April, 1894, issue of this paper the reader will see that during the preceding 12 months there were 450 accidents, in which 108 engineers and 114 firemen lost their lives, and that 251 engineers and 223 firemen were injured. This means that there has been a falling off of something more than 11 per cent. in the total number of accidents, and that the rate of death and injuries has risen 6⅔ per cent. and fallen 1⅔ per cent. respectively; which, being interpreted, may be made to mean that while the total number of accidents have fallen off they have been individually more serious, and that therefore it would appear that the cutting down of expenses and the crippling of the service has resulted not only in increasing the number of accidents per train mile, but has tended to make those accidents that do occur more disastrous than they would have been under normal conditions. We do not wish to be understood as making this as a positive assertion, but merely as putting it forth as a suggestion for one of the reasons of what has occurred. The following is a list of the accidents that we reported for 1894 in which an engineer or fireman was killed or injured:

Blowing out of cylinder head	2
" " " plug	1
Boarding train in motion	1
Boiler explosions	15
Break in two	1
Broken axle	1
" connecting-rods	2
" rails	5
" side rods	5
" tires	1
" trucks	2
Burned bridges	1
Bursting arch-pipe	1
" gauge-glass	4
Cars blown on track	2
Cattle on track	19
Caught between cars	5
Cave-in	1
Collisions	116
Crushed under engine	1
Cut in cab window	1
Defective air brake	1
" bridges	7
Derailments	36
Falling from engine	10
Flying reverse lever	1
Forest fires	2
Gas explosion	1
Jumping from engine	5
Landslides	14
Misplaced switches	27
Obstructions on track	6
Open drawbridge	1
Overturning of engine	1
Rails spreading	3
Repairing grates	1
Runaway engines	1
" trains	5
Running into hand-car	2
" off float	1
Run over	8
Stone-throwing	2
Strikers	6
Struck by ash-pan lever	1
" " car on siding	2
" " engine	2
" " obstruction	8
" " train	2
Suffocated by snow	1
Suicide	1
Thrown from engine	2
Train burned	1
" robbers	3
" wrecking	26
Trestle burned	3
Tubes bursting	3
Unknown	11
Washout	5
Total	399

Referring to this list, we find that collisions are by far the most prolific sources of danger, there having been 116 during the year; next come derailments, at 36; misplaced switches, 27; train-wrecking, 26; cattle on the track, 19; boiler explosions, 15; landslides, 14; and those attributed to unknown causes, 11. If we compare this with the similar list published in March, 1894, we find that the accidents, taken in the order of frequency, stand in nearly the same relations in both instances. At that time they ran: Collisions, falling from engine, misplaced switches, boiler explosions, struck by obstruction, cattle on the track, runaway engine and unknown. From this comparison of nearly two years of observations it would seem that one is warranted in asserting that collisions are by long odds the most fruitful source of railway disasters, and that derailments and misplaced switches are a close second. While train-wrecking has assumed a prominent place in the records of the past year, this danger cannot be said to be a defect in the railway system. One-half of the total cases of train-wrecking of the year occurred during the months of July

and August, at the time of the strike of the American Railway Union, and it is not unreasonable to attribute the epidemic to that as the cause. Such accidents as boiler explosions, land-slides and cattle on the track are of about equal importance, and should be attributed to the departments responsible. The mechanical department must father the explosions, the chief engineer the landslides, and the road department the cattle on the track. Not that all of these disasters should be put directly upon the shoulders of the heads of these several departments, but they are supposed to see that the work confided to them is executed with safety and diligence; and while many accidents occur that it would undoubtedly be impossible to avert by any human foresight, it is equally true that many are directly due to carelessness in maintenance, inspection, or construction for which no excuse can be found. Acting on this basis, and taking the accidents as they are recorded, we should place the responsibility as follows:

Operating department	189
Road "	68
Mechanical "	44
Personal negligence	44
Violation of the criminal laws	37
Unassignable	17
Total	399

Thus, out of 399 accidents 345 are traceable to the several departments, the mechanical department being responsible for about 12¾ per cent. of the 345, or 11 per cent. of the whole. In reviewing these accidents one year ago, we said that "the predominance of collisions over every other form of accident simply means that suitable provision has not been made for the protection of trains; in short, that the block system is not considered necessary." It would be interesting and somewhat startling, too, we think, if the facts bearing on the accidents of collisions and misplaced switches could be investigated so that the exact ratio due to a lack of suitable signals could be ascertained. Then, if we could obtain the actual cost to the railroad companies of these disasters, there is but very little doubt that a substantial payment could be made on the cost of equipment with interlocking signals had these accidents not occurred. The great trouble in the introduction of the block system is that when an accident does not occur there is no means of presenting an estimate of the saving that might be made in case it had. There is a disposition to consider that as long as the horse has not been stolen there is no danger that he will be. But in reviewing such a mass of matter as that embraced in these reports one is struck, on making the comparison, with the small proportion of minor collisions and derailments that occur on roads that have an interlocking system of signals in use, as compared with those that are not so equipped; and were it not that comparisons are exceedingly odious in some cases, it would be possible to call attention to the marked falling off in the frequency of accidents of this class on certain roads that have put the block system into use.

With the exception of these isolated instances, we regret to be obliged to come to the conclusion that there is no change in the conditions of the safeguards existing on the roads of the United States from that prevailing one year ago. There are about the same number of minor accidents, such as the collapsing of tubes, the bursting of water-glasses, and defective construction in small details; the only improvement that is decidedly apparent is the smaller number of boiler explosions. These have fallen away by nearly one-half; and while this may be attributed to the smaller number of boilers in use, we are disposed to think that the agitation of the subject of boiler inspection by several of the railway clubs during the past season has had something to do with the awakening of the men in charge to the great importance of this branch of the service. and that there is actually an improvement in the condition of affairs. But even though this may be so, there is ample room for further advance; still it must be a matter of congratulation to the mechanical departments that they are responsible for less injury to life and property than either the road or operating departments. One reason for this may lie in the fact that the *personnel* is of a rather higher grade than that employed on the track and on the trains, and a higher standard of discipline can be maintained, but many of the defects of the operating department would probably disappear if it was provided with a better means of handling and controlling the movement of the trains over the road, while the accidents attributable to the road department would fall off if engineers were more particular about the location of signal posts and other obstructions near the line of rails, for there is hardly a month wherein we are not called upon to chronicle the maiming or killing of an engineer or fireman struck by some object placed so near the rails as to strike the man as he leans from the cab window or gangway—a condition for which there is no possible excuse, and which is truly a case of criminal negligence.

EARLY DAYS OF THE IRON MANUFACTURE.*

By John Fritz.

In deference to a custom long established, by which the president-elect is expected to read a paper on some subject with which he is more or less familiar, I have thought that a brief review of the methods employed in the manufacture of iron, as witnessed by myself, and reaching back to 1838, would interest some of our older members and give our younger ones a glimpse into the trials and difficulties encountered in those early days by the pioneers in this great industry.

In 1840, 12 to 20 tons of pig iron was the make of a furnace per week—at this time from 1,200 to 2,000 gross tons.

In 1840, 3 to 4 tons No. 4 wire rods per turn. They have lately made 176 gross tons in 11 hours.

In 1840 I have not the quantity of puddled iron made; but it was small, as puddling was in its infancy. In 1890, there was made 2,518,174 gross tons.

The earliest rolling-mill statistics are in 1856, in which we produced a total of 498,080 gross tons of all kinds of rolled iron.

In 1840, we produced of pig iron 286,903 gross tons; in 1890, 9,202,703 gross tons, which is more than has been produced by any other nation.

The incidents of which I shall make mention were of such an every-day, practical character that they never have found their way into print.

My first practical experience in iron-making was in 1838, while a cub apprentice in a country machine and blacksmith shop, when I was sent out to a charcoal furnace to do some repair work. The furnace was blown by water power, the motor being an undershot wheel having a wooden shaft, in the ends of which were secured cast-iron winged gudgeons, one of which had a crank cast on it, in which the crank-pin was inserted that drove the connecting-rod and piston in the wooden blowing-tubs, as they were called. The dimensions of the furnace are unknown, but it made about 12 tons of iron per week when it worked well; and when it did not work well, which was often the case, it made none. The particular job I was sent to do was to put in a new blast-pipe connecting the main blast-pipe with the tuyere of the furnace; and when I got it up in place, to my chagrin, I found it did not reach the opening in the stack by about 10 in., the conclusion being that some one had made a big blunder, something that happened sometimes, even in those days; and the supposition was that it must have been the man who made the pipe, as the workmen in those days took their own measurements, and in case of a mistake they generally got what we called a "blowing up," and if the error was made by a cub, he got an especially rough one. While I was thinking the matter over, and wondering if I had better take the pipe back to the shop, several miles away, or move the furnace up to meet it, the man who ran the furnace, or founder, as he was called, came along, and his appearance just at this juncture was not a pleasant one for me, as I expected that when he saw that the pipe did not reach the tuyere he would give me a blast, and a hot one as well. To my surprise, he looked at it for a moment, and said it was just right. But while this let me out, I could not but think it ought to have reached to the tuyere. I afterward learned that the connection was made with a leather pipe called a boot. I still thought they ought to go into the tuyere.

In the neighborhood where I spent my younger days there were several mills for rolling boiler plate, and as a boy I spent much time in watching what at that time was an interesting sight to me. While there were several mills there, the one I propose to speak of was the oldest, and, as it is claimed, the first mill in the United States to roll plates to make boilers, it then having the reputation of making very superior plates, and, I am glad to say, it still sustains its early acquired fame. As a history of this mill reaches back more than fifty years from the time I first knew it, my knowledge of its beginning was obtained from the old people who lived in the neighborhood and from some of the old workmen who had been employed in it, and I hope what they told me will interest you, as it did me to hear it.

In 1790, Isaac Pennock, the great-grandfather of the present proprietors of the Lukens Iron & Steel Company, began the manufacture of iron at a place on Buck Run, Chester County, Pa., called Rokeby, about four miles south of Coatesville. Isaac Pennock was raised as a farmer in the neighborhood, and his parents strongly objected to his going into a business

* Presidential address at the Bridgeport meeting of the American Institute of Mining Engineers.

about which he knew nothing, as they felt he would squander his money. The mill he first built was called the Federal Slitting Mill. In 1810 he bought a saw-mill property on the Brandywine, near Coatesville, which he converted into an iron mill. This mill, which at the time was called the Brandywine, has since developed into the immense plant it now is.

In 1816 Dr. Charles Lukens, a son-in-law of Isaac Pennock, came into possession of the property, and carried on the business of iron-making until his death, which occurred in 1825; and it is claimed that it was between these dates that the first boiler plates were made in this country and in this mill. At the death of Dr. Lukens, his widow, in accordance with his special request, continued to carry on the business, although handicapped by the fact that there were no railroads in those days and the finished iron had to be teamed to Philadelphia, a distance of 36 miles, or to Wilmington, Del., 26 miles, while the coal used was hauled from Columbia, about 35 miles away; yet, in spite of these difficulties, she carried on the iron-making business, hiring a superintendent to look after the works and the workmen, while she herself managed the business of the office. Mrs. Lukens was considered an extraordinary business woman. She built up a business which has been continuously successful up to the present, and which has remained in the same family for four generations; and it was in honor of her extraordinary abilities that the name of the works was changed from Brandywine to Lukens.

Originally the sheets were made from a single charcoal bloom, the bloom having been made in the old-fashioned forge fire, then reheated over an ordinary grate fire and rolled into plates or sheets, which sheets were shipped without being sheared, the shearings in those days being cut into nails. But afterward they put up a reverberatory heating furnace, in which they worked up the scrap themselves. The plate rolls, as near as can now be ascertained, were about 16 to 18 in. in diameter, and from 3 to 4 ft. long in the body, and were driven by an undershot water-wheel. It is said that many a time, when it looked as if the mill would stall, the workmen would rush for the water-wheel, climb upon its rim, and by their united weight help the pass through the rolls, thus preventing a stall, which meant fire cracked rolls, and, later on, broken ones. This water-wheel was afterward supplemented by a breast-wheel so geared as to give more power to the rolls. This enabled them to use larger rolls, but the gearing gave so much trouble that they finally abandoned the use of the water-wheel and put in a steam engine and enlarged their rolls to 21 in. in diameter and 66 in. between the journals. This was again changed to 25 in. in diameter and 84 in. long chilled rolls. After several other changes, they at last put in three high-chilled rolls 34 in. in diameter by 120 in. long, a large Corliss engine to drive them, automatic lifting tables, etc.

The weight and size of the early boiler plates, as made on the oldest mill, I have been unable to get; but it is not supposed that they attempted anything weighing over 500 lbs., and probably 300 lbs. was nearer their limit. As an illustration of the changes that have taken place in this one mill I would say that, as now enlarged, they readily roll plates 119 in. wide and 50 to 60 ft. long. The little old mill, in which the workmen had to climb on the wheel to help make it go round, is one of the best plate mills in the country, and its owners and managers are the great-grandchildren of Isaac Pennock, who in 1790, built the Federal Slitting Mill on Buck Run, and, in 1810, on the banks of the Brandywine, what was called the Brandywine Mill.

In the year 1845 I went to Norristown, Pa., and assisted in the building of what, at that time, was considered the best mill for making bar iron in this country; in fact, it was called a model mill, and in many respects it was so. While it was a geared mill, it was so much better built than any other mill of the kind that it was expected that it would give little or no trouble on that score. But we were sadly disappointed; for, soon after starting, the gears began to give way, the back-lash and the jar of the rolls causing the teeth to break and drop out.

I was given charge of the machinery, and, of course, had to look after the gear-wheels. At times the entire wheels would seem to go to pieces at once; at other times the arms would crack, and then again the teeth would break—each break, of course, stopping the entire mill. Then all hands had to work day and night to get started again. At first we had to go to the foundry to get such parts as had been broken made over. This, of course, caused considerable delay, and to avoid this loss of time we began to keep segments of gearing on hand, and we had separate wrought-iron teeth made ready for insertion, and kept clamps ready to strengthen broken arms. With such extended experience, I became quite an expert in inserting teeth, and it was no doubt due to this fact that on the occasion of several hundreds of my friends coming to Bethlehem not long ago I was arrested at the banquet and tried on the charge of practising dentistry without first having procured a license or diploma!

Soon after the mill started, I was placed in charge of it on the night-turn, including the puddling furnaces and the few heating furnaces used for rolling covers. While this added somewhat to my duties, it proved of great advantage to me, as it gave me an opportunity to obtain a practical knowledge of iron-making. Later on, I was given charge of the mill on the day-turn, which practically meant both day and night, as it was during the day that everything had to be arranged for the night-work before supper could be eaten or rest obtained, and often to the loss of both. In a short time I received, in addition to my other duties, that of having charge of the roll-turning and of seeing that the iron rolled was properly finished. In short, I, who had entered the mill as a machinist, was now in charge as an iron-master; and it was in connection with this new departure that my troubles began.

In those early days the chemistry of iron-making was unknown—at least in this country—and iron-makers were often but the blind leading the blind. At the present time, if there is any trouble with the product of an iron or a steel mill, the chemist is sent for, and he is expected to carefully analyze the ore, fuel, flux, cinder, and even the furnace linings, and find and eliminate the troublesome element, whatever it be, that is damaging the product. But in the early days of iron-making we had no such help, and had to feel our way as best we could.

The process of making bar-iron by the use of the charcoal forge had become too expensive for iron to be used for ordinary purposes, and the art of making bar-iron by the puddling process was the only other means of any promise to which we could turn for relief. Puddling was at that time done by what was called the fermenting process, in which white iron only could be used; and we soon learned that only a few brands of pig iron could thus be worked into merchantable bar-iron, as by reason of being cold short it often proved worthless; and the worst of this was, we did not know what caused it. As the works were built to make high-grade bar-iron, which must be neutral, we were in a great quandary, not knowing which way to turn; but as the only way out was to keep on experimenting, we did so, sometimes finding a pig metal that gave good results. Then all at once it would go wrong again, and why, we could not tell, but it was always in order to lay it on the poor puddler and to give him a good "blowing up."

At times we found that by mixing several brands of charcoal-pig we would get good results; but as the price of bar-iron was low we could not afford to use high-priced pig, and so we began to experiment with anthracite iron—and with the old-time troubles, or even worse, as we got both cold and red-short iron. At this time one of the blast furnaces which had been making charcoal-iron began to use anthracite coal for fuel. In our distress we tried some of their pigs and got quite good results, the bars not being cold-short, but quite inclined to red-shortness, and for many purposes, such as shafting, car axles, heavy bolts, etc., proving very suitable. But for the use of the blacksmiths the iron was quite unfit. They then knew nothing about working red-short iron, and, of course, they condemned it.

We have now learned that good fibrous iron can be made from anthracite pig-metal, but for the highest grades of bar-iron we were still compelled to use charcoal-pig, and in the old way. It would occupy too much of your time to relate in detail the long series of experiments, often ending in disaster, we went through, never knowing when the iron would be good or what it was that made it red, until at last, by accident, we stumbled on the cause of the trouble.

We noticed that when, after making red short iron for a time, a change was made to neutral iron, the iron was still inclined to red-shortness. In a day or two the red-shortness would die out, and we would get on to good bar iron; and it gradually dawned on us that the trouble might come from the cinder that was left in the furnace when red-short iron was being made. So when we next changed over from red-short to neutral iron we cleaned all the cinder out of the furnace with great care, and refixed it with neutral cinder, and to our great joy found that the secret of our troubles had been discovered, and that we could now make neutral or red-short iron as we wanted to, with a tolerable degree of certainty.

While the experiences and trouble gone through were both perplexing and annoying, they proved of great value to me in after years, and especially when we began to make steel by the Bessemer process; for I had early learned how a very small percentage of an objectionable element, either in the ore, the metal, or the fuel, would greatly damage the product. In addition to the trouble we were having in making the iron, we were constantly breaking gearing, spindles, or rolls and couplings. In order to reduce the cost of repairs as much as

possible, we tried to have some part of the train made strong enough to do the work when everything was going right, and weak enough to break when anything was going wrong. This was, of course, a cut-and-try business; sometimes the part we intended to break would be made of extra strong iron, and then it would fail to break and some other part would give way; then we would reduce the pattern and make it lighter, and the next casting made of that pattern might happen to be weak iron, and it would break too easily, and then we would have to strengthen the pattern again; and so from day to day we went on, with one break after another, varied occasionally by the giving way of a coupling-box, spindle or breaking-box. The latter would let the end of the roll rise up in the housings, and if the roll was a collared one, off would go the collar, and the roll would be ruined. Of course, the breaking of teeth in the gear-wheels was a common occurrence; and so much trouble came from this source that I remember that, over 45 years ago, I was almost inclined to register a vow that I would never again have anything to do with a piece of machinery that had a cog-wheel in it.

In the year 1854 David Reeves, together with a few of his friends, leased a works for making iron rails, located at Johnstown, Pa. I was sent there to complete the mill and to superintend its working. As it was at this place where afterward great and important changes in the manufacture of rails were introduced, I have thought that a brief history of the works would be of some interest to the members of the Society.

The works were originally commenced by an organization called the Cambria Iron Company, but after the mill was partially built their money gave out, and the project was considered a failure. It was at this time that David Reeves, Matthew Newkirk, George Trotter, and a few others, joined together and leased the plant as it stood; Mr. Reeves, Mr. Trotter and Mr. Newkirk being the most prominent in the matter, and Mr. Newkirk acting as the business manager.

Mr. Newkirk then gave me instructions to go to work at once and complete the mill as soon as possible. Having previously examined the works with great care, I can assure you that it was with serious misgivings that I undertook the task. There was a vast amount of new work to be supplied, and I had very serious doubts as to the efficiency of what had previously been done. From what I learned as to the kind of pig-iron that was to be used, the outlook was anything but encouraging, and I came to the conclusion that there was serious trouble in store for me when the mill would be ready to start; and I can now testify that my forebodings were fully verified later on.

When we at last got to work and rolled a few rails, the edges of their flanges looked like saw-teeth, and the head was rough and full of small holes, and everybody about the mill, from the owners to the water-boy, was disgusted and sick. This was especially true concerning the heaters and the men about the rolls, for they were paid by the ton of finished rails. It was the general conclusion that something would have to be done, and right quickly, too. There were three charcoal blast-furnaces that belonged to the company, one of which happened to be in blast at the time, so we got some charcoal-pig and puddled it and rolled it into covers for the bottoms of the rails, the common iron being above them. These piles were rolled so as to put the charcoal-iron on the edges of the flanges. This worked pretty well as far as the flanges went, but it did not cure the trouble with the heads; so we had to roll other covers for the tops of the piles, to make the head of the rail good; and with hot and cold patching, and a liberal use of putty, we managed to get some rails that passed muster. By continually experimenting in the piling of the iron, and changing mixtures, we finally got out some fairly good rails; but the engine and fly-wheel driving the train were of such a construction that it was not safe to run it over fifty revolutions per minute, which was too slow to make rails out of the materials we were using.

One of the most serious troubles was that the forward end of the pile would split open in the rolls, so that, when we came to enter it in the next pass, it refused to go in, and much time was lost in bunting it in the buggy, consequently cooling the pile to such an extent that when the rolls did get hold of it, spindles, coupling-boxes, and sometimes the rolls themselves, would break, causing both expense and delay, which, in connection with the general depression in business, led to troubles that brought the enterprise to an end.

Again a new company was formed, and it was known as Wood, Morrell & Company. It was in part made up by David Reeves, Charles Wood, Matthew Newkirk, George Trotter, D. J. Morrell, John Shoenberger, and E. Y. Townsend. Mr. Charles Wood was made President, E. Y. Townsend, Vice-President, and D. J. Morrell, General Manager. The change in the organization of the company did not, however, change the troubles in the manufacture of the rails nor increase the output, both exceedingly important matters, which, unless they could be greatly improved, would still leave the handwriting of failure on the wall. Having, in view of the past, and remembering my former doubts, gone over the entire subject again, I made up my mind as to what must be done to make a success; and I was prepared to submit my plans and recommendations to the new company.

My plan was to build an entirely new train of rolls, and to make them three-high and 20 in. in diameter. This involved a new engine with a fly-wheel that could be run at 100 revolutions should it be desirable to do so. In fact, it practically meant an entirely new rail-mill. When the plan was submitted to the company they said at once it could not be done, for the reason that the expense would be too great; and besides, the mill they had was an entirely new mill, which was supposed to be the very best in the country, and they did not see why it could not be made to do good work. Finally, I succeeded in convincing some of the managers that something must be done, and that if they would adopt my recommendations I was certain of success. After consulting together, they directed me to go on and build an 18-in. two-high geared train to take the place of the train we had. To this I replied in the most emphatic manner that I would not do it, as it would be money thrown away. To my refusal, they said the position taken was a most arbitrary one, and one I had no right to take, as I was in their employ on a salary to manage their works, and that they had some right to say what should be done. To this I assented partially, but at the same time told them that if they continued in the line they were in there would in a short time be held a large funeral, and I did not intend to stay and attend it. At this the meeting adjourned.

In a few days they gave me permission to go on and build such a mill as I wanted, but they thought it would be better to make the rolls 18 in. instead of 20 in. in diameter; and, by way of compromise, I consented (which was a mistake), and began to build the new train and make other important changes about the mill.

About the time we had the patterns for the new train and engine completed we were brought to a stop by a protest in the form of a legal document, holding the managing partners personally responsible for the building of a new mill. This, of course, was an unexpected stunner, and all work was suspended.

One Sunday morning, when, as I now realize, I ought to have been at church, Mr. Townsend came down to the mill, where I was alone, and brought with him the legal protest and read it to me. After all these years, no person other than myself can fully appreciate the trying position the managers were in. On the one hand, I was urging them to go on and build a mill on an untried plan, and absolutely refusing to build the two-high geared mill they asked for, feeling that such a mill would only in a small way mitigate the troubles we had gone through, and that the money spent on such a plant would be thrown away. On the other hand, there was a strong party of stockholders protesting in the most positive manner against going on with my plans, and notifying the managers that they would hold them personally liable for all the loss and damage that might grow out of their unwise action, as they considered this action to be, in adopting a new and untried method that was against all practice in this and the old country, from which at that time we obtained our most experienced iron-makers. Besides, prominent iron-makers in various parts of the country had said to Mr. Morrell that the whole business would end in a failure, and that man Fritz would ruin them. The heaters and rollers were also opposed to my plans, and they appointed a committee to wait on the managers and to say to them that the three-high train would never work; that they themselves would suffer by reason of its adoption, but that if the managers would put in a two-high geared train, which was the proper thing to do, the mill would go all right.

As I look back to that eventful Sunday morning long years ago, when, sitting on a pile of discarded rails, with evidences of failure on every side, Mr. Townsend and myself quietly and seriously talked over the history of the past, the difficulties of the present, and the uncertainties of the future, I cannot but feel, in view of what has since come to pass, that it was not only a critical epoch in the history of the Cambria Iron Company, but as well the turning-point in my own life. For, as Mr. Townsend rose to leave, after a long conference, he turned to me and said: "Fritz, go ahead and build the mill as you want it." I asked: "Do you say so officially?" To which he replied: "I will make it official." And he did so.

I want to avail myself of this opportunity to say that to no other person so deservedly belongs the credit, not only of the introduction there of the three-high roll train, but of the subsequent wonderful prosperity that came to the Cambria Iron

Company, as it does to E. Y. Townsend, then its Vice-President. Nothwithstanding I had now the consent of the company to go on, many of my warmest friends, some of whom were practical iron-workers, came to me and urged me not to try so foolish an experiment. They said I had taken a wrong position in refusing to build the kind of a mill the company wanted ; that in all probability the mill I was getting up would prove a failure, and, being a young man, my reputation would be ruined for life. To this I replied that possibly they were right in what they said, but that I had given the subject the most careful consideration, and was ready to take my chances on the result. The work was now pushed on as fast as possible. In the construction of the rail-train I made a radical departure from the old practice, which was to provide breaking pieces here and there. I tried to make everything so strong that nothing would break. One of the previous methods was to make coupling-boxes and spindles so that they would break when any extra strain would come on them, and the leading spindle had a groove cut around it so that it would be sure to break before the rolls. The result was the constant breaking of some of these safety devices. In addition to all these devices there was what was called a breaking-box on top of the rolls which held the roll in position, which was made hollow, so as to crush if the strain was too great. I directed the pattern-maker to make it solid. The head roller, seeing the pattern was solid, went to the pattern-maker to have it changed and made hollow, as he supposed it had been made so by mistake, but the pattern-maker refused to alter it, as he said the "old man" (as they called me 40 years ago) had ordered it to be made that way. "Well," said the roller, "the old man has gone crazy ; and if that box is put in as it is the mill will be smashed to pieces, and I am going to see him about it," which he did, and, of course, I told him the box was going in solid, as I would rather have one grand old smash-up once in a while than be constantly annoyed by the breaking of spindles, couplings and breaking-boxes ; to which he replied : "Well, you'll get it."

The new mill having been prepared and ready to put in place, the old mill was stopped on the evening of July 3, 1857, and after the Fourth I commenced to tear the old mill out and put the new one in, and also to put in the new engine, while at the same time I remodelled everything about the rail department, and raised the floor-line 2 ft. On the 29th of the same month everything was completed and the mill was ready to be started. I need not tell you that it was an extremely anxious time for me, nor need I add that no engraved cards of invitation were sent out, that not being the custom in the early days of iron-making ; and, indeed, if it had been, it would not have been observed on that occasion. As the heaters to a man were opposed to the new kind of a mill, we did not want them about at the start. We however secured one out of the lot, who was the most reasonable one among them, to heat the piles for us, and we kept the furnace smoking for several days as a blind. At last, everything being ready, we charged six piles. About ten o'clock in the morning the first pile was drawn and went through the rolls without the least hitch, making a perfect rail. You can judge what my feelings were as I looked upon that perfect and first rail ever made on a three-high mill ; and you may in part know how grateful I felt toward the few faithful men who were about me, and who had stood by me during all my trials and difficulties, among whom were Alexander Hamilton, the superintendent of the mill, and Thomas Lapsly, who had charge of the rail department, William Canam and my brother George. We now proceeded to roll the other five piles. When two more perfect rails had been rolled we were obliged to stop the engine, for the reason that we were so intently watching the rolls that the engine had been neglected, and, being new, the eccentric strap, for want of oil, got hot and bent the eccentric rod so much that the engine could no longer be worked. As it would have taken some time to straighten the rod and reset the valves, the remaining piles were hauled out from the furnace on the mill floor. About this time the heaters, hearing the exhaust of the engine, came into the mill in a body, and from the opposite end to where the rails were. Seeing the unrolled piles lying on the floor, they took it for granted that the new train was a failure ; and their remarks about it were far from being complimentary. Mr. Hamilton, coming along about that time, and hearing what they were saying about the mill, turned around, and using language more pointed than polite, told them that if they would go down to the other end of the mill they would see three handsomer rails than had ever been made in their country. The next day, which was Friday, we ran all day, and at night put on the regular night-turn. Everything worked well up to noon of Saturday, it being our custom to stop rolling at that time. About six o'clock in the evening, Mr. Hamilton and myself left the mill, and on our way home we congratulated each other on the fact that our long line of troubles and disappointments was now over. About an hour later I heard the fire-alarm whistle blow, and rushing back to the mill, found it one mass of flame from one end to the other. In less than one hour's time the whole building was burned to the ground, and a story started that the new machinery was a total failure, and that we had burned the mill to hide our blundering mistakes.

The situation of affairs on that Saturday night was such as might appal the stoutest heart ; the result of our labors and anxieties lay there a mass of black and smoking ruins, and the money that had been so hard to get with which to build the new works was gone. The prospect was gloomy, but there was one gleam of light amid all the darkness, and that was the pile of new and perfect rails which, as Hamilton had said, had never been beaten by Wales, from which country most of the iron rails used here came. Above all, the mill had been tried and found to work magnificently, and it was these two facts that gave us all fresh courage, and enabled us to rebuild the mill.

The following day, Sunday, was devoted to rest and to thinking over the matter ; at any rate, it was not spent in the mill. On Monday morning we commenced to clear up the wreck and to begin the work of rebuilding. In four weeks from that time the mill was running, and made 30,000 tons of rails without a hitch or a break of any kind, thus making the Cambria Iron Company a great financial success, and giving them a rail-mill far in advance of any mill in the United States—a position they held unquestioned until the revolutionary invention of Sir Henry Bessemer came into general use, and steel rails pushed to the wall the rails previously made of iron. I do not now intend to speak of the wonderful change this invention of Sir Henry Bessemer brought about in this country, nor of the enormous increase in the production of rails it made possible. It is but just to say that some credit for this great increase is fairly due to the introduction of the three-high roll-train first erected, amid the most discouraging conditions, in the mill of the Cambria Iron Company at Johnstown 37 years ago.

The use and advantages pertaining to the three-high train were by no means confined to the making of iron or steel rails. Let any practical man go into the iron or steel mills of this country, and he will see, not only how they have served to increase production, but also how in many ways their use has necessitated other improvements, all of which have brought about more perfect work.

If the knowledge we had in the early days of making bar-iron and rails was incomplete and crude, it was not more so than the knowledge displayed in making pig-iron. About 1838 or 1839, Mr. Kunzi, at that time a member of the firm of Farr & Kunzi, large manufacturing chemists in Philadelphia, and one of the ablest chemists of the time, made some experiments with a view of smelting iron with anthracite coal, and about 1842 or 1843 he built a blast furnace on the Schuylkill River at Spring Mill, and after several unsuccessful attempts to make iron in it he sent for Benjamin Perry, a practical furnace-man, to come and take charge of his new furnace, which he did, and succeeded in getting it in good working shape and making fairly good iron.

Mr. Kunzi was thereupon congratulating Mr. Perry on his success, and said, that while he himself knew all about the chemistry of iron, he knew nothing about the making of it. To this Mr. Perry replied that he knew nothing about chemistry, but he did know how to make iron. Shortly afterward Mr. Perry thought he could do better by going elsewhere and blowing in other anthracite furnaces, and asked Mr. Kunzi to let him off. This Mr. Kunzi did not wish to do, and he invited Mr. Perry to come up to his house, with a view of trying to induce him to remain. In connection with this, quite an amusing story is told. During the interview Mr. Kunzi talked about the chemistry of iron-making, and of the combustion of coal, etc., and consequently had a good deal to say about oxygen and hydrogen, all of which became rather tiresome to Mr. Perry, who supposed that he had been invited there to have a drink, and he said to Mr. Kunzi : "I don't know a d——d thing about hydrogen or oxygen, but if you have some good Holland gin, I'll take some of that."

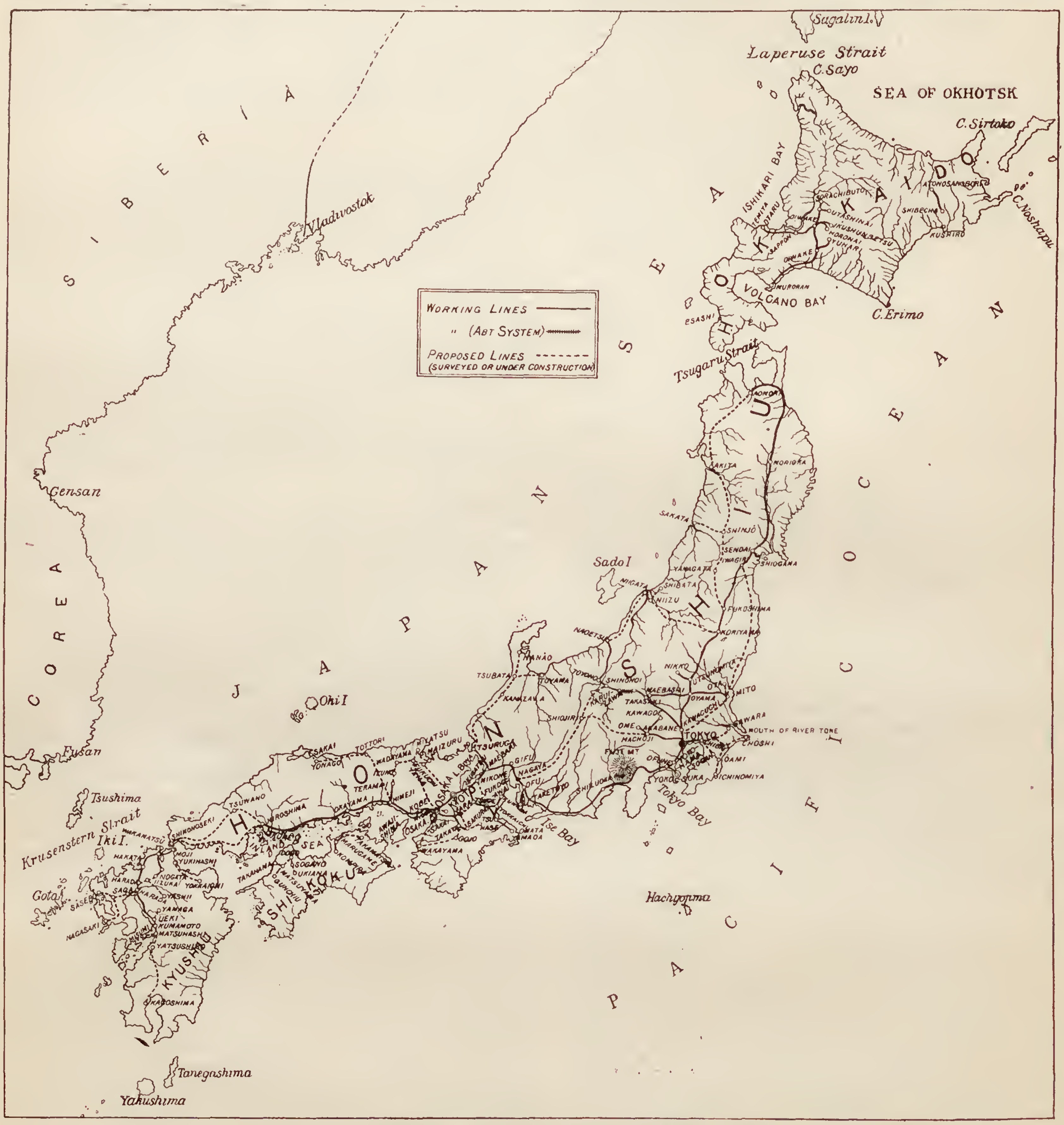
Some fifteen years later it was my fortune to have the same founder in charge of the blast-furnaces at Cambria, as even at that time he was looked upon as being the most practical blast-furnace man in the country. While he was with me, my friend, John Griffin, of Phœnixville, paid me a visit, and he wanted to meet Mr. Perry. So I had him come up to my house, where they soon got to talking on blast-furnace practice ; and among other things Mr. Griffin asked him about the coal they were using for making coke, to which he replied that it was bad, being full of brass. Mr. Griffin said : "Mr. Perry, you

mean iron pyrites." "Well," said Perry, "you may call it what you d——d please, but I tell you it's brass," and the manner in which he spoke was so emphatic that Mr. Griffin wisely concluded not to pursue any further that branch of the subject. Yet the speaker was the best practical furnace-man that I knew at that time.

Gentlemen, I have already taxed your patience far beyond what I intended when I began this paper; but the subject is one in which I have been greatly interested all my life, and perhaps it is not strange that I have dwelt upon it to the extent I have. Yet, after all, I feel that I have come far short of showing you the real condition of the iron business when I first became connected with it, 56 years ago. I would like to have described the shops and the tools we then had; but time will not permit. The younger members who visit the immense iron and steel plants of the present day will never know how the old-time iron maker managed to get along with only the commonest and crudest tools and appliances, many of which have long since gone out of existence. In the machine-shops in which we built our engines and mills there were very few tools other than the hand-hammer, cold chisel and file; and I must say that, in the hands of the skilful, hard-working mechanics of those days, there was not much they could not accomplish.

I would not feel that I had done my whole duty in my reference to the iron-making of the past, in which I had a part, did I not place on record my admiration of and my obligation to the trusty, faithful and stalwart men whom during these many years, from time to time, I had about me. They were, for the most part, uneducated young men from off the adjoining farms, or had received their training as woodsmen or as workers in the collieries, charcoal furnaces, or bloomeries scattered about in the hills; they knew little of science or of school training; but they were courageous, faithful, hard workers, who knew nothing of short hours or of resting when there was important work to be done, and they had lots of good common sense, which helped them and me out of many a tight place. There were, in addition to the men I have spoken of, and on whom I so much relied in times of break-downs and disasters, a large number of puddlers who, for the most part, in the early days of iron-making, were Welshmen, and in addition to their being skilful iron workers, generally good men and good citizens.

It is on such an occasion as this that the roll-call of memory



MAP. SHOWING THE RAILWAYS OF JAPAN.

brings back to me the faces and forms of my early associates who were engaged with me in the various enterprises of which I have spoken. Nearly all have passed away; but I honor the memory of those who have gone, as I thank those still living for all they did to help and encourage me through the trials and anxieties of the past.

RAILWAYS AND ENGINEERING IN JAPAN.

The accompanying engraving represents a map of Japan, showing the lines of railways. The Japanese Empire consists of four large islands (Hokkaido, Honshiu, Shikoku and Kiushiu) and 407 small islands. (In the map the Kurile Islands on the north and the Loo Choo Islands on the south are not shown.) The north extremity of the Kurile Islands is 50° 56′ north latitude, and the south extremity of the Loo Choo Islands is 24° 6′ north latitude; the east extremity of the Kurile Islands is 156° 32′ east longitude, and the west extremity of the Loo Choo Islands is 122° 45′ east longitude. The total area of the empire is 156,604 square miles, and the coast lines 17,575 miles, including its dependencies. The population is 40,720,000. The general aspect of the country is mountainous and is full of running streams. The largest island, Honshiu, is traversed throughout its whole length by a regular mountain chain, of which Fujiyama is the loftiest peak, attaining an elevation of 12,370 ft. above sea level. The mountain is of a regular conical shape, being an extinct volcano, whose top is covered with perpetual snow. The largest river is Tone-gawa, which is about 2 miles wide near the mouth. The largest lake is Lake Biwa, which is 500 square miles in area, from which a canal was constructed to the city of Kyoto.* The country is full of picturesque scenery.

There are two ocean currents which surround the Japanese Islands. The one is a warm current, called Kuroshiwo, and the other a cold current, Oyashiwo. The former comes from the Philippine Islands, being a continuation of the great equatorial current of the Pacific Ocean, which is deflected from the islands after impinging. This warm current washes the coasts of the Loo Choo Islands and branches into two streams, the principal one flowing along the Pacific coast of Kiushiu, Shikoku and Honshiu, and the other along the Japan Sea coast of these islands. The latter, or cold stream, comes from Kamchatka past the Kurile Islands and flows along the east coast of Hokkaido, and after combining with the warm current sets out to the Pacific Ocean. Owing to this cold stream the southern coast of Hokkaido and the east coast of Honshiu are frequented with dense fogs, which makes navigation difficult. The temperature of the cold current is below 32° F. in winter, and it reaches 60° F. in summer, while the warmer current is 10° higher than the colder current both in winter and summer.

After the revolution in 1868 Japan has undergone a great social, commercial and political change, and the country made a great progress in public works. After the first railway of 18 miles from Shinbashi (Tokyo) to Yokohama was opened in 1872, the line has been and is now being prolonged as follows:

JAPANESE RAILWAYS.

Working Lines in Hokkaido.

		Miles.	Chains.
Tanko Railway Company	Temiya-Iwamizawa Line	47	5
	Iwamizawa-Muroran "	83	48
	Oiwake-Yubari "	26	49
	Iwamizawa-Ikushunbetsu Line.	11	..
	Horonaibuto-Horonai Line	2	17
	Iwamizawa-Sorachibuto Line	24	75
	Utashinai Branch Line	6	..
		(201	34)*
Kushiro Railway Company	Shibecha-Atonosanobori Line	25	78
		227	32

Working Lines in Honshiu.

		Miles.	Chains.
Niphon Railway Company	Ueno (Tokyo)-Awomori Line	455	..
	Omiya-Maebashi Line	52	20
	Utsunomiya-Nikko Line	25	..
	Akabane-Shinagawa "	13	..
	Iwagiri-Shiogama "	4	20
	Oyama Mito Line	43	..
		(592	40)
Ryomo Railway Company	Oyama-Maebashi Line	52	17
Imperial Government Railways	Shinbashi*Kyoto (Tokaido) Line	328	40
	Kyoto Kobe Line	47	40
	Ofune-Yokosuka Line	10	..
	Ofu-Taketoyo Line	14	..
	Maebara-Tsuruga	30	..
	Takasaki-Yokokawa Line	18	..
	Yokokawa - Karuizawa (Abt System) Line	7	..
	Karuizawa-Naoetsu Line	92	10
		(547	10)
Kobu Railway Co	Tokyo-Hachoji Line	22	77
Sobu " "	Ichikawa-Sakura Line	25	..
Kawagoe Railway Co	Kokubunji-Kawagoe Line	18	20
Omu " "	Ome-Tachikawa Line	13	7
Sano " "	Kazuw-Koina Line	9	50
Kansei " "	Yokkaichi-Kusatsu Line	49	25
	Kameyama-Tsu Line	9	60
	Yokkaichi-Kuwana Line	8	7
		(67	12)
Sangu " "	Tsu-Omata Line	24	..
Osaka Railway Co	Osaka-Nara & Sakurai Line	32	55
Hankai " "	Osaka-Sakai Line	6	35
Bantan " "	Himeji-Teramai Line	18	..
Sanyo " "	Hiogo-Hiroshima Line	189	62
Total Working Lines in Honshiu (Main Island)		1,618	65

Working Lines in Shikoku.

		Miles.	Chains.
Sanuki Railway Co	Marugame-Kompira Line	10	15
Iyo " "	Matsuyama-Takahama Line	5	66
		16	1

Working Lines in Kiushiu.

		Miles.	Chains.
Kiushiu Railway Co	Moji-Hakata-Saga & Kumamoto Line	136	61
Chikuho " "	Wakamatsu, Naogata, Iizuka. Kotake & Kaneda Line	40	..
		176	61
Total Working Lines in Hokkaido, Honshiu, Shikoku, and Kiushiu		2,038	79

Lines Under Construction.

		Miles.	Chains.
Imperial Government Railways	Ou Line (Fukushima, Yonezawa, Yamagata, Akita & Awomori Line)	298	..
	Hokuroku Line (Tsuruga-Kanazawa, & Toyama Line)	124	..
Tanko Railway Co	Muroran Branch Line	3	..
Ota " "	Ota-Mito Line	12	18
Sobu " "	Honjo-Ichikawa Line.	5	..
Boso " "	Sogano-Oami Line	11	75
Kansei " "	Kuwana-Nagoya Line	23	13
Nara " "	Nara-Kioto Line	25	53
Bantan " "	Teramai-Ikuno Line	12	57
Nanwa " "	Takata-Gojo Line	16	40
Sanyo " "	Hiroshima-Shimonoseki Line	120	..
Nanyo " "	Matsuyama-Gunchiu Line	6	57
Dogo " "	Matsuyama-Dogo Line	3	6
Hoshin " "	Yukihashi-Yokkaichi Line	43	65
Kiushiu " "	Saga, Sasebo, Nagasaki, Kumamoto, Misumi & Yatsushiro Line	135	60
		841	44

Lines Surveyed.

		Miles.	Chains.
Imperial Government Railways	Chino (or Central) Line: Hackoji-Kofu L.	54	64
	Kofu-Suwa "	38	64
	Suwa-Nagoya "	129	25
	Renraku (or Junction) Line (Himeji-Tottori Sakai Line)	135	27
	Shinonoi Line (Shinonoi-Shiojiri Line)	41	55
	Kagoshima Line (Matsuhashi-Kagoshima Line)	102	66
	Kare Line	13	..
	Tsuwano Line	157	..
Niphon Railway Co	Kawaguchi-Uchihara Line	60	..
	Nakazato-Senji Line	3	..
	Mito-Iwanuma "	130	..
Sakata " "	Sakata-Shinjo Line	31	..
Ganetsu " "	Koriyama Niizu Line	100	70
Hokuetsu " "	Naoetsu-Shibata Line & Niizu-Nuttari Line	98	45
Kano " "	Tsubata-Nanawo Line	34	70
Sobu " "	Sakura-Choshi Line	42	40
Shimosa " "	Sakura-Sawara "	23	30
Boso " "	Chiba-Sogano & Schinomiya Line	24	5
Omi " "	Hikone-Fukagawa Line	27	56
Kyoto " "	Kyoto-Ayabe-Wadayama - Ayabe-Maizuru-Miyatsu Line	100	6
Hankaku " "	Kanzaki-Fukuchiyama Line	63	35
Hase " "	Sakurai-Hase Line	14	40
Kisetsu " "	Wakayama-Osaka Line	40	..
Kiwa " "	Wakayama Gojo "	31	20
Kansei " "	Nara-Tsuge Line	31	57
Bantan " "	Ikuno-Wadayama Line	12	76
Sanuki " "	Marugame Takamatsu Line	17	60
Iyo " "	Soga-Ukiana Line	3	14
Chikuho " "	Iizuka-Yamaga-Harada Line	15	65
	Yamaga-Yoshii Line	14	70
	Katsuno Line	3	40
Yamaga " "	Yamaga-Ueki Line	10	42
		1,608	22

* See American Engineer and Railroad Journal, January, 1893.
† In order to avoid complexity, omit the figures within the parentheses.

* Shinbashi is in the southeastern extremity of Tokyo.

ENUMERATION.

	Miles.	Chains.
Lines working	2,038	79
Lines under construction	841	44
Lines surveyed	1,608	22
Total	4,488	65

In the present Japo-Chinese war these railways are doing great service in sending out an army to Corea and China. The capital hitherto expended for the construction of Japanese railways is about $120,000,000, and much more will be required for proposed future railways. A war fund, amounting to $150,000,000, was voted in the House of Parliament, so that some of the capital intended for new railways will be absorbed by it.

Besides the railways worked by locomotive there are more than a hundred miles of tramways for horse cars. Some of them are going to be changed to electric propulsion, and new lines of electric tramways are also being proposed.

The working railroads serve as mail lines with 28,859 miles of main lines. Over these and the country roads of minor importance millions of carriages are running, which are necessary for transportation in the interior. In addition to these lines of land carriages there are the following mail line steamers on the water:

16,646.83 nautical miles on sea and ocean
120.52 " " " rivers
12.00 " " " lakes

The number of post-offices throughout the empire are 3,704, including 535 of post and telegraph offices. The following figures give the length of government telegraphs in Japan:

Length of lines, 8,639.43 miles } on land.
" " wires, 24,802.48 "

Length of lines, 211.27 miles } cable under seas.
" " cables, 269.89 "

Length of lines, 3.44 miles } cable under rivers.
" " cables, 8.52 "

For the Japo-Chinese war Japanese military telegraphs were constructed in the lands of Corea and China.

There is a telephone exchange in the principal cities in Japan, of which the lengths are:

Length of lines .... 384.10 miles
" " wires .... 3,312.83 "

In addition to these government lines there are some hundred miles of telephone lines belonging to private individuals. The telephone lines at present are of single wires. As the electric tramway is now being constructed in the city of Kyoto, the lines in that city are to be altered to double wires. Electric power is used in the city, and also in mining districts in many provinces.

Within the last eight years electric light companies were formed in principal cities and towns, of which the length of lines are as follows:

Length of lines .... 191.03 miles
" " wires .... 762.45 "

The lines are overhead system, with a minor exception in Tokyo. Most of the electric-light companies are working with steam engines, but some have water-power stations, as in Hakone, Nikko, Maebashi, Kirin, etc. Besides these lines belonging to companies, there are electric-light plants specially constructed by private individuals, such as in gentlemen's mansions and in mines. There are several kinds of dynamos and lamps used in Japan—Edison's, Thomson-Houston's, Brush's, Bentley-Knight's, Westinghouse's, Siemen & Halske's, Bagnall & Hilles', etc.

In common with other countries, after the adoption of electric lights, gas-lights became of minor importance in Japan. There are now only 23½ miles of gas pipes. Water supply of principal cities and towns is now being improved. There are 250 miles of the approved system of water-works. They are mostly iron pipes, but there are some built with earthenware or wooden pipes.

The system of sewerage in Japan must be improved, especially in cities. But it is a very difficult question to settle upon the system that will suit the peculiar condition of the country. The common water-carrying system is not suitable, as the excreta are used for agricultural purposes.

Concerning the irrigation systems in Japan, travellers are struck with the careful way in which water is supplied to rice fields in every part of the country. In order that the rice fields may be properly supplied from rivers, the river beds are required to be higher than the surrounding fields, which renders the river engineering difficult.

From the nature of the country it will be seen that the physical characteristics of the rivers are very different from other countries. They are mostly mountainous torrents in the upper parts and become sluggish toward the mouth. The quantity of discharge is very small in ordinary condition, but in spring and autumn the state of affairs becomes quite different, when freshets take place as a result of thawing of snow and the long rains. The old Japanese system of protection was levees with crib-work and long bamboo basket work filled with stones.* Within the last quarter of a century fascine works were introduced, which seem to be preferable in lower parts of Japanese rivers.

The works of harbor engineering have also been carried on within the last fifteen years, and at present the construction of Yokohama Harbor is being executed, the capital for which is for the most part the remuneration of the Shimonoseki battle paid by the American Government. This expenditure of the fund was voted after due consideration by the Japanese Government, for the proper use of an income of such a nature.

As for the Japanese marine, besides 18,293 sea-going vessels of the Japanese style, there are 1,421 vessels of European style, of which 466 are steamships above 100 tons; 703 are sailing ships above 100 tons; 177 steamships below 100 tons; 75 sailing ships below 100 tons.†

The number of small vessels and boats sailing on sea-coasts, lakes, rivers and canals are 585,456, including fishing and pleasure boats. There are arsenals and private dock-yards, where ships, even men-of-war, are made.

The whole coasts of the Japanese Islands are properly illuminated. There are 221 lighthouses, buoys and beacons, besides 3 lightships. Fog signals are also provided in localities subject to fogs of great density. Some of the lights are fixed, while others are revolving or flashing. The height of the lighthouses to the centre of lantern is from 15 to 99 ft., the height of the light above the sea varying from 29 to 397 ft., their range of visibility being from 6 to 20½ miles.

In regard to the construction of houses, bridges and other works, those which were of temporary character have been and are still being replaced with substantial works, proper consideration being taken for earthquakes, which often visit the country. The architecture of the Western style introduced in Japan is nice, but the nicest is the neatly built houses of Japanese style, a fine specimen of which we have seen in the Wooded Island in the World's Fair.

The mineral wealth of Japan is enormous, and the mining industry of the country made a rapid stride within the last ten years, and the following figures give an idea of the mineral products for one year:

Gold	23,500	oz.
Silver	1,702,000	"
Copper	303,000	piculs
Copper sulphate	460	"
Lead	13,000	"
Tin	800	"
Antimony	54,000	"
Arsenic	1,900	"
Manganese	44,000	"
Iron	25,000	tons
Copperas	15,800	piculs
Coal	3,000,000	tons
Sulphur	443,000	piculs
Graphite	7,600	"
Petroleum	2,020,000	galls.

The annual mineral products amount to about $20,000,000, and these minerals seem almost inexhaustible in the islands.

The development of the manufactures in the country is observed by travellers, who meet with many workshops and chimneys in different provinces. There are splendid silk factories, spinning and weaving works, rice-refining works, paper mills, iron works, cement manufactories, brick manufactories, porcelain working shops, tea-making shops, glass works, oil and other chemical manufactures, etc., which are well organized.

In the national exhibition which is to be opened in Kyoto in April, 1895, in celebration of the eleven hundredth anniversary of the Emperor Kammu, the advancement of engineering and manufactures within the last five years will be seen. Now is the time that the tide of wealth is flowing toward the Land of the Rising Sun in the Far East.

* See AMERICAN ENGINEER AND RAILROAD JOURNAL for November, 1894.
† The steamers of steamship companies make regular trips on the coasts of Japan. The Niphon Yasen Kaisha is the largest company who has full-powered steamers carrying mails and excellent accommodations for passengers. The steamers of the Company make regular trips to the coasts of Corea, China, Siberia, and to Bombay.

WATER-TUBE BOILERS AND THEIR APPLICATION TO WAR VESSELS.*

By J. Nastoupil.

(*Concluded from page* 36.)

XI. The Normand boiler (fig. 31) is very similar to the Thorneycroft boiler in its general design. Like the latter, it consists of two horizontal water drums and a steam drum of round cross-section lying above it, to which a steam dome is added. The heating tubes are also curved, but they are fastened into the lower side of the steam drum, so that their ends are below the water-line. There is also a variation in the construction of the circulating tubes which are placed at each end of the boiler.

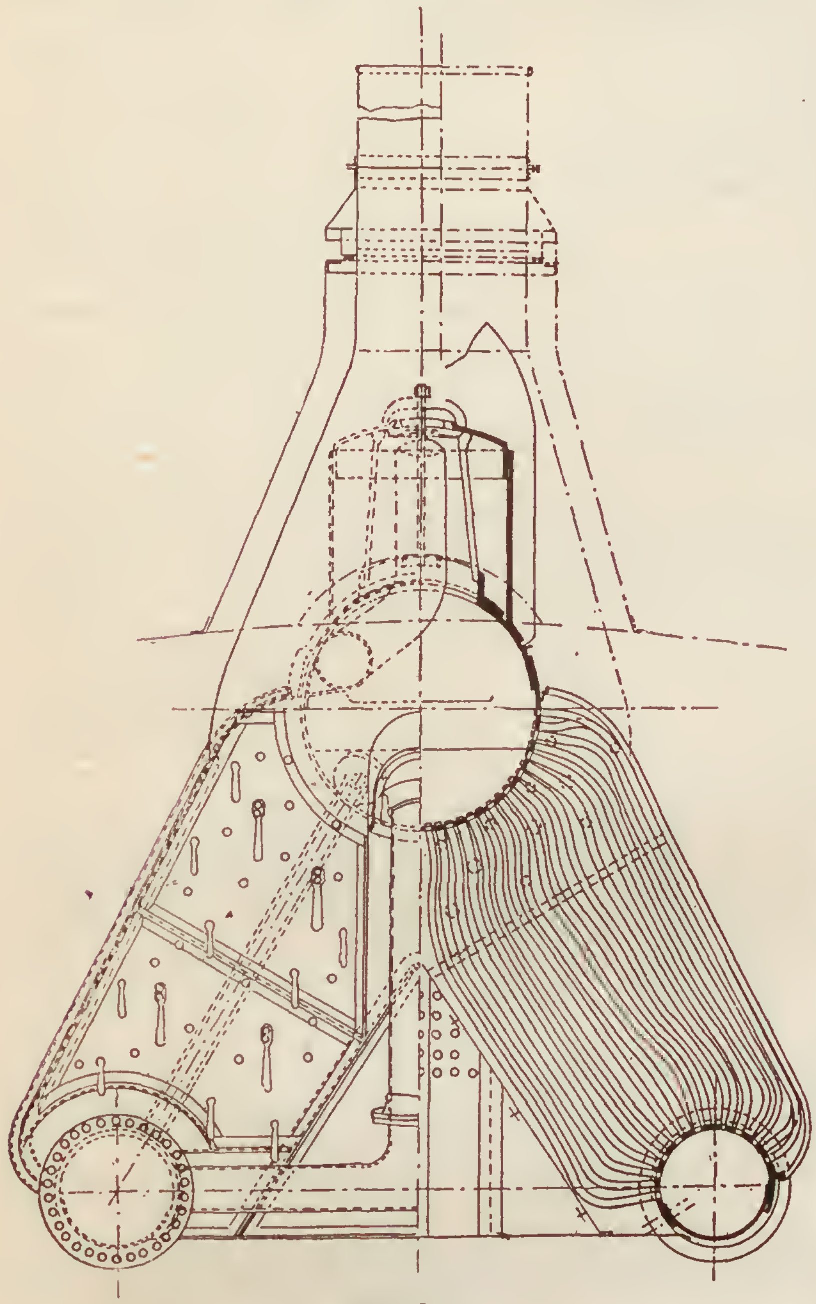


Fig. 31.
THE NORMAND BOILER.

XII. The Du Temple water-tube boiler (fig. 32) consists, like the Thorneycroft and Normand boilers, already described, of two horizontal water drums and a horizontal steam drum lying above it, which is connected with those first named by a number of thin water tubes and by two circulating tubes led down outside of the casing. The two water drums have a comparatively small rectangular cross-section, and are fitted throughout their whole length with hand-holes, through which access to the inside is gained. The water tubes, which have the zigzag form shown in the engraving, enter the steam drum below the normal water-level. As the grate is set between masonry walls, all of the water tubes lie above the fire, and the products of combustion pass across them.

XIII. The Fleming & Ferguson water-tube boiler (figs. 33–37) has two or more cylindrical water drums beneath, while a steam drum of a larger diameter is placed above them. Each water drum is connected to the steam drum by bent tubes of from ½ in. to 2½ in. in diameter, wherein the arrangement of tubes is such that in case any tube should become damaged it can be drawn out into the steam space, from which another can be put in position. For this purpose especial spare lengths of tubes can be kept on hand, which in case of necessity can be cut to a proper length. The ends of the tubes are made fast in the shells of the cylinders by rolling.

This type of boiler can be constructed either as a single or as a double boiler; in the latter case the furnaces can be arranged either at the sides or at the two ends. The boiler casing consists of two plates of sheet metal with the intervening space filled with asbestos.

Water-tube boilers of this type have been built for a working pressure of 300 lbs. per square inch, and have been tested by a hydrostatic pressure of 650 lbs. per square inch.

XIV. The White water-tube boiler (figs. 38–41) consists of two water drums and a steam drum, which is cylindrical in form and located above the two others. Both water drums have as their main connection to the steam space a set of spiral water tubes, each two of which forms an element. The whole boiler is enclosed in a double-walled sheet metal casing, whose back wall is protected by a range of tubes, which consists of special water tubes set close together. In order to insure circulation of the water, the back end of the boiler is furnished with circulating pipes that drop down outside of the casing. The furnace is enclosed between two tubular side walls which are formed of water tubes set close together.

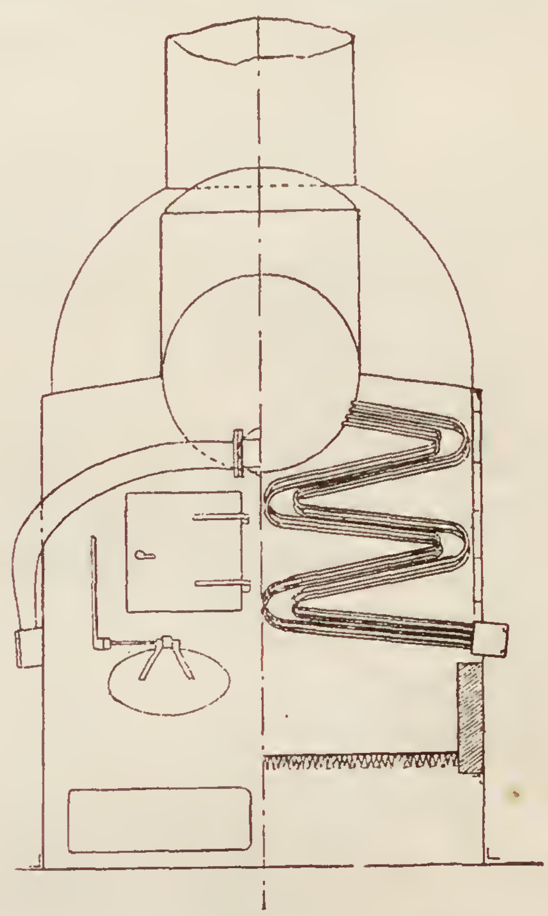


Fig. 32.
THE DU TEMPLE BOILER.

The products of combustion first rise from the grates and pass to the back wall, and are then turned in the opposite direction through side passages on either side toward the front where they rise into two smoke-stacks.

ADVANTAGES OF THE WATER-TUBE BOILER.

The advantages which the water-tube boiler possesses over the ordinary cylindrical boiler can be treated under three heads, as follows:

a. From a Constructive Standpoint.—For an equal factor of safety against explosion, the thickness of the walls of the tubes of water-tube boilers can be very much thinner than the shells of ordinary boilers, whereby a boiler can be constructed for a higher working pressure of steam than that for which the shell and heating surfaces of the ordinary boiler can be made without an excessive thickening of the material, where the safety is jeopardized by the use of sheets that are defective, either from lack of homogeneity, bad manipulation in shaping or other constructive defects.

Outside of the great saving in weight that can be achieved, water-tube boilers require, on account of the compactness of their construction, less space, and carry, in consequence of their smaller volume, a lesser weight of water.

* Paper read before the Wissenschaftlichen Verein der k. und k. Kriegsmarine.

Water-tube boilers can be built in separate parts, which makes them easily transported ; and this special type is further available where a change of boilers must be made in a ship without involving the necessity of tearing up the deck for this purpose.

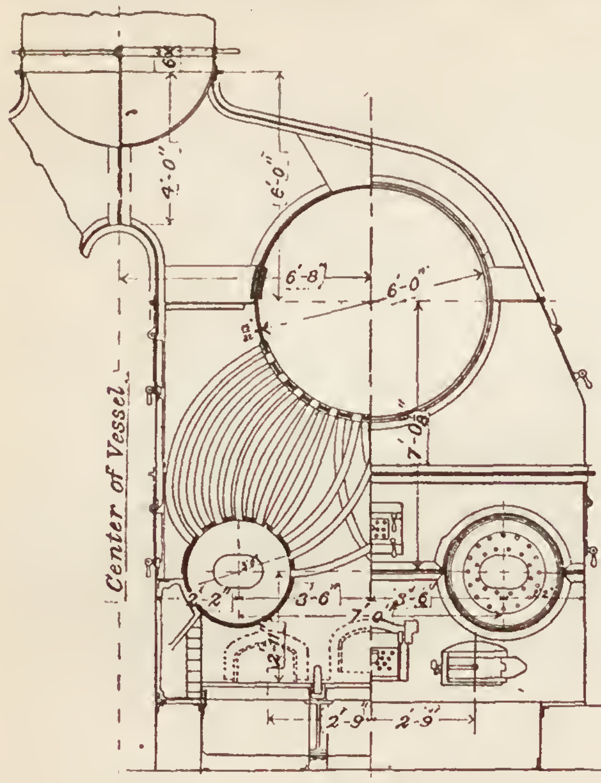


Fig. 33.

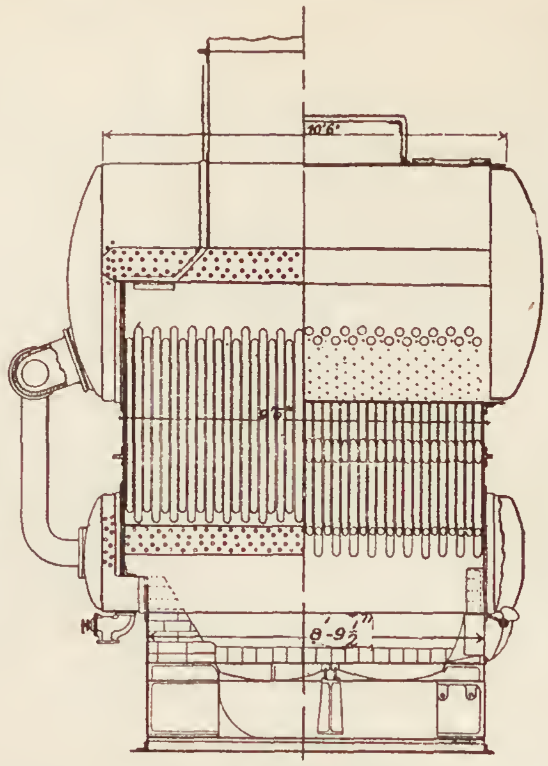


Fig. 34.

THE FLEMING & FERGUSON BOILER.

Finally, it may be added that on account of the better circulation of water, and by reason of the better arrangement of the heating surface, the products of combustion are not carried on in lines parallel to that surface, but directly at right angles to it, thus raising its efficiency to a marked degree.

b. From the Working Standpoint.—As the working of the boiler is of the first importance, it is very essential that the working of water-tube boilers should receive the closest attention ; yet, if the attention should be slack, the efficiency does not fall away to so great an extent as would be the case with ordinary boilers. The thin walls can be brought into direct contact with the flame without any danger, provided only that a sufficient circulation of water is maintained in the boiler, and that that water is pure.

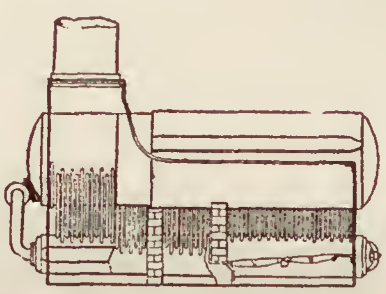


Fig. 35.

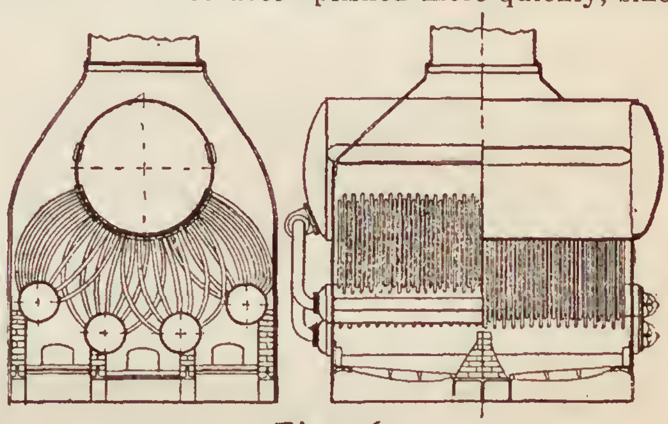


Fig. 36.

THE FLEMING & FERGUSON BOILER

The water-tube boiler can be forced into a rapid generation of steam without any of those disastrous consequences which ordinarily occur in the case of cylindrical boilers. The vigorous circulation of the water maintains all parts at a practically even temperature, prevents the formation of scale on the heating surfaces and assists in the liberation of the steam.

The defects that occur in water-tube boilers are mostly of a local nature, and the damages resulting therefrom will, on account of the small quantity of water in the boiler, be very much less than in the case of other types. Worn-out or damaged water-tube boilers can be easily and quickly changed on board, so that the interruption in service will be correspondingly diminished.

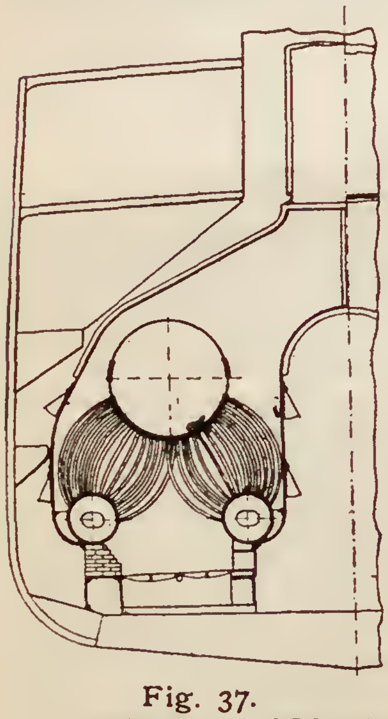


Fig. 37.

THE FLEMING & FERGUSON BOILER.

As water-tube boilers consist of a number of similar parts, these parts can be easily and without inconvenience kept on hand.

c. From a Military Standpoint.—The rapid raising and generation of steam without producing any bad results, as can be done with water-tube boilers, is a matter that is intimately connected with the fighting capabilities of a battle-ship.

Let us compare two equally large battle-ships, one of which is fitted with cylindrical or locomotive types of boilers, whereas the other is equipped with water-tube boilers. The latter, instead of lying under steam, in expectation of the enemy, whereby it will quickly exhaust its coal supply, will know that under the circumstances the boilers can be allowed to cool off, and that as soon as the necessity may arise steam can be rapidly raised. In locomotive boilers it requires from one to two hours to raise steam to a working pressure after the kindling of the fire ; simple cylindrical boilers require from two to three hours, while four hours must be consumed in the large cylindrical boilers. As this is a considerable length of time, it is of the highest importance to a battle-ship that it should be equipped so that steam can be raised in from twenty-five to thirty minutes without injury to the boiler.

Hence the vessel fitted with water-tube boilers can, at the end of this short space of time, begin its operations with full coal bunkers, clean boilers, and a crew in the engineer's department that is fresh and vigorous. It may be further remarked that the attainment of full speed with water-tube boilers is easier and can be accomplished more quickly, since the changes in working intensity are not correspondingly greater than in cylindrical boilers.

As to the advantages accruing from the saving in weight, due to the application of water-tube boilers, the following data will be of interest :

The Danish third-class cruisers *Hecla* and *Geiser* are vessels of the same type, of equal displacement (1,300 tons), and with engines of the same H.P. Both are fitted with two vertical triple-expansion engines, but the boilers are different. On the *Hecla* there are six cylindrical boilers, while on the *Geiser* there are eight Thorneycroft water-tube boilers. In both cases the boilers were designed to supply steam for 3,000 I.H.P., and their weights are as follows :

	Hecla.	*Geiser.*
Boiler with tubes, feed pumps, breeching, stacks, and all necessary fittings........................	120.2 tons.	90.8 tons.
Water contained in boiler........................	48.0 "	17.4 "
Total....	168.2 tons.	108.2 tons.

There is thus a saving of 60 tons, or more than one-third in the weight of the boilers of the *Geiser* over those of the *Hecla*. According to the official report regarding the performance of the former, 3,157 I.H.P. was maintained with a consumption of 35 lbs. of coal per square foot of grate surface, with an air pressure in the fire-room of 0.81 in. water column. In the official report to the Danish authorities, Captain Nielson says:

"During the test the boilers worked remarkably well, and the steam pressure was maintained with the greatest ease. The steam production could be instantly regulated to correspond with the consumption of the engine by means of the steam cut-off valve of the fans.

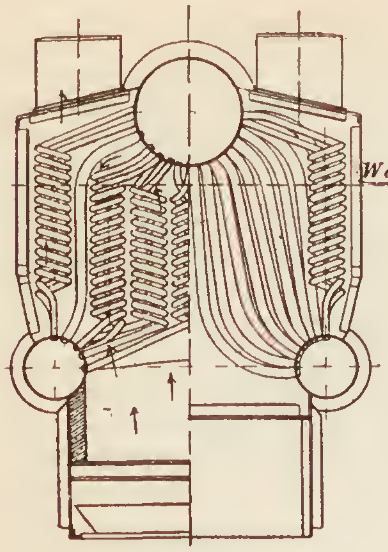


Fig. 38.

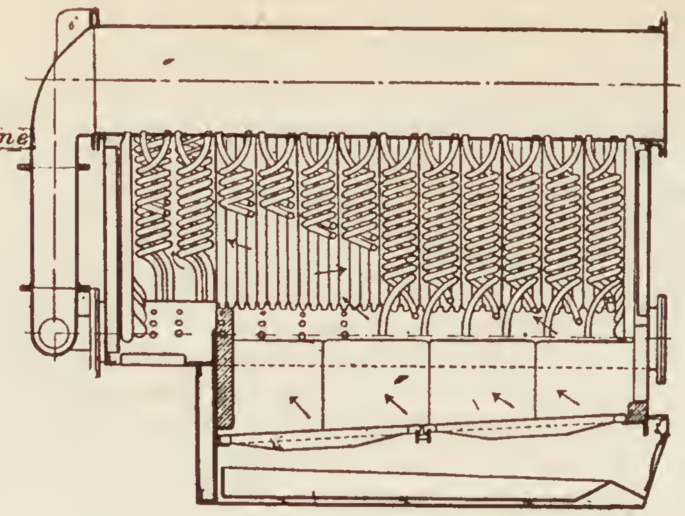


Fig. 39

THE WHITE BOILER.

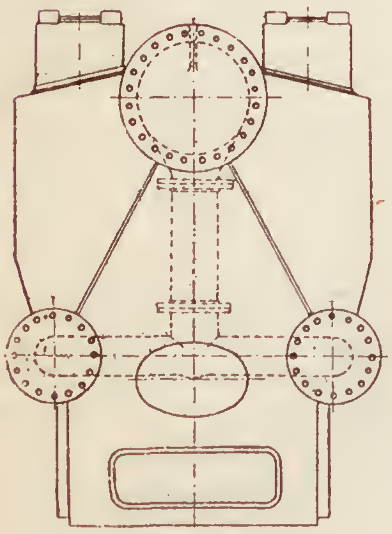


Fig. 40.

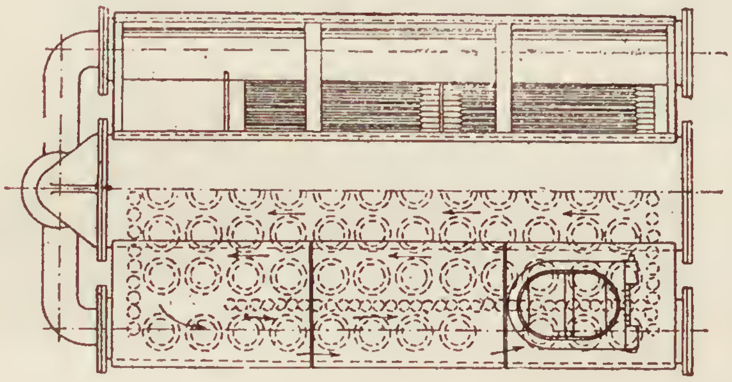


Fig. 41.

THE WHITE BOILER.

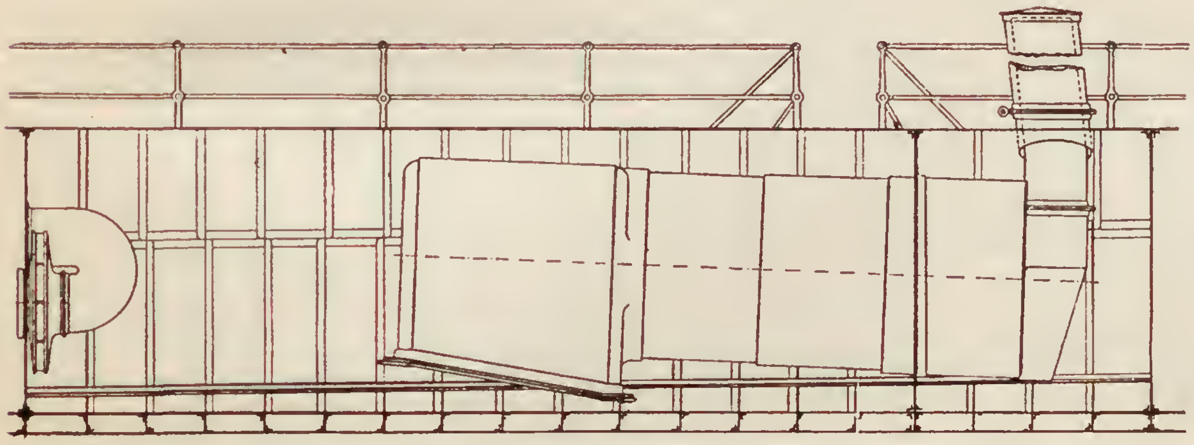


Fig. 42.

THE LOCOMOTIVE BOILER.

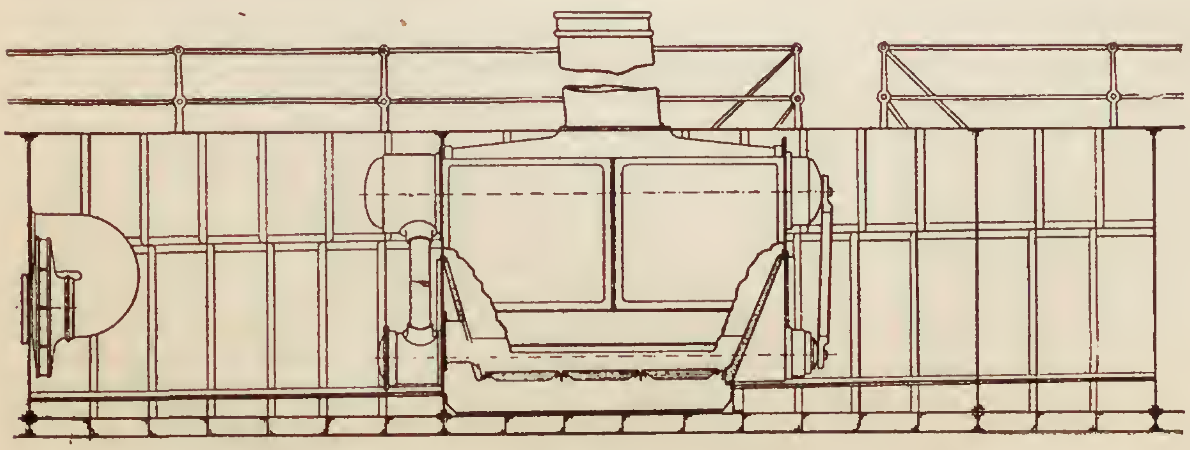


Fig. 43.

THE THORNEYCROFT BOILER.

' After a run of more than seven hours and a half at sea, as well as at the conclusion of the test, the engine could be brought up to 3,314 I.H.P. at once by the use of an air pressure equivalent to .6 in. of water, and the steam production for this high service could be maintained by a pressure of 1 in. of water.

" We frequently made sudden stops of the engine while at full speed, and could bring the vessel back to full speed again in a few minutes without paying any particular attention to the boilers, since they were in a condition to sustain sudden changes of temperature. The boilers primed neither during the greatest forcing nor when there was a sudden change made in the work of the engine.

" The *Geiser* can make ready to start in three-quarters of an hour, and could do it in half an hour if so much time were not required for warming the engines."

The English torpedo boats *Havock* and *Hornet*, each of which has a length of 180 ft. and a beam of 18 ft. 6 in., are both equipped with triple-expansion engines, but have different types of boilers. The *Havock* has two locomotive-form boilers, while the *Hornet* has eight water-tube boilers of the Yarrow type. The total weight of the boilers and attachments in the *Havock* is 54 tons, and in the *Hornet* 43 tons, giving the latter a saving in weight of 11 tons. Both vessels were built by the same firm (Yarrow & Co.), who guaranteed one knot higher speed for the *Hornet*.

For the *Havock* it was guaranteed that on a three hours' trial the engines should develop 3,200 I.H.P., with a steam pressure of 165 lbs. per square inch, and with from 2 in. to 3 in. of water pressure should exceed it by 200 I.H.P.; while on the *Hornet*, in a run of the same duration and with a steam pressure of 169 lbs. per square inch, with an average air pressure of $1\frac{1}{2}$ in. of water, a mean efficiency of 4,000 I.H.P. was maintained, which gave the vessel an average speed of 27.628 knots.

The saving in space which was effected by the substitution of a Thorneycroft water-tube boiler in place of a locomotive-form boiler of the same capacity, whereby a saving of 4 tons in weight was also obtained, is shown in figs. 42, 43.

The remarkable changes of temperature that can be wrought in water-tube boilers are well shown by the following test :

A separate trial of a water-tube boiler for the torpedo-boat *Hornet* was made on shore, when within twenty minutes and twenty seconds from the time of kindling the fire a pressure of 180 lbs. per square inch was obtained, and this pressure was maintained for half an hour by opening the fan valve to its full width and using an air pressure of from 3 in. to $3\frac{1}{2}$ in. of water, while the amount of steam drawn off corresponded to that which would be required by an engine developing about 780 I.H.P. Then, in a space of six minutes, the fire was hauled and the boiler

allowed to cool off with the fire-doors open, so that after a lapse of thirty-two minutes the pressure had dropped to 70 lbs. per square inch without the slightest leak developing in any part of the boiler.

It is also worthy of our attention to note the capacity shown several years ago in a test made of the boilers of the English torpedo-boat *Speedy* of 810 tons. This vessel was built by the firm of Thorneycroft & Co., and contained eight water-tube boilers designed for a working pressure of 250 lbs. per square inch. According to the contract, there was to be a test of eight hours' duration, showing an average capacity of 2,500 I.H.P., with a maximum air pressure of 3 in. of water, and a test of three hours' duration giving a mean capacity of 4,500 I.H.P., with a maximum air pressure of 5 in. of water.

In the eight hours' test an average production of 3,046 I.H.P. was obtained, and in the three hours' trial an average of 4,700 I.H.P. was obtained, and that, too, without any special forcing.

The navies of France, England, Russia, Spain, Denmark, and the United States are making applications of water-tube boilers in considerable numbers to vessels of all sizes. On large ships the Bellville or Lagrafel d'Allest boilers are used of about equal sizes, while upon the smaller craft the Oriolle, Du Temple, Normand, Thorneycroft, Yarrow, and other boilers of a similar type are applied.

The necessity of economizing space, and at the same time securing a large heating surface with the least possible amount of material, together with a greatest available capacity, as well as insensibility to variations in the intensity of working, show the principal advantages of water-tube boilers, and the reason why they are receiving a continually increasing application to the new vessels that are being built by most of the naval powers. Water-tube boilers also offer a welcome means, if it is desired, of clearing a ship when a change of boilers is required, of insuring the maintenance of its speed, if not actually increasing it, and of gaining space for a given service, thus increasing the cargo space or enlarging the radius of action.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.

SECOND SERIES.—CHEMICAL METHODS.

XIII.—METHOD OF DETERMINING AMMONIA IN AMMONIUM CHLORIDE.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(*Continued from page* 33.)

OPERATION.

Have ready the apparatus shown in accompany cut or its equivalent. Put 25 c.c. of standard sulphuric acid into the smaller Erlenmeyer flask, and connect this with the apparatus as shown. Then weigh into the larger flask half a gram of the ammonium chloride, and connect this flask in its place as shown. Then add through the funnel tube 75 c.c. of caustic potash solution, and close the stop-cock of the funnel tube as soon as all the caustic potash solution has run in. Light the lamp, and bring the liquid to a boil, and continue the boiling gently until about 50 c.c. of liquid has been added to the smaller Erlenmeyer flask. Now detach this flask from the rest of the apparatus at the top end of the pipette. Wash out the pipette on the inside and the lower part of the outside with distilled water, to remove any liquid that may be adhering to it; also wash down the sides of the flask and allow to cool. Then titrate the excess of free sulphuric acid in this flask with standard caustic potash solution, using methyl-orange as indicator.

APPARATUS AND REAGENTS.

The special apparatus required by this method consists, as is seen, of a 16-oz. Erlenmeyer flask fitted with a rubber stopper, which carries a funnel tube provided with a glass stop-cock, and an exit tube which is enlarged above the cork and has in the enlarged part an inch or two of glass balls or beads. The smaller or 8-oz. Erlenmeyer flask is fitted also with a rubber stopper which carries an exit tube and a 100 c.c. pipette, so arranged that the end of the pipette reaches almost to the bottom of the flask and always below the surface of the acid. The top of the pipette and the top of the exit tube from the 16-oz. flask are connected by means of a rubber stopper, a simple bent glass tube and a bit of rubber hose as shown. The 16-oz. flask is supported by a universal clamp on a retort stand in such a way that the glass tube connecting the two parts of the apparatus inclines a little toward the larger flask, to allow condensed water to run back. A second clamp on the same retort stand sustains the sand bath, which is adjusted to the bottom of the 16-oz. flask. A Bunsen burner protected by a sheet-iron or tin shield to keep off drafts of air furnishes the necessary heat.

The phenolphthalin solution used in standardizing the acid and alkali is made by dissolving 5 grams of the commercial material in 100 c.c. of 95 per cent. alcohol, and adding caustic potash until the solution shows a slight pinkish tint.

The methyl-orange solution is made by adding 1 gram of the commercial material to 400 c.c. of water and filtering.

The potash solution used in the 16-oz. flask is made as follows: Take a beaker holding about 40 fluid ounces and put a mark on the outside at 30 oz. capacity. Put into the beaker 200 grams of commercial caustic potash in sticks and add 36 oz. of distilled water. After solution is complete, boil down to the mark in order to remove any ammonia that may be present. Pour the liquid into a bottle for use.

The standard alkali and acid solutions are made as follows: Take about 50 grams of the best dry C. P. carbonate of soda, free from silicate, to be obtained in the market. Dissolve in distilled water and filter into a platinum dish. This is to remove any sand or dirt that may be accidentally contained in the soda. Add a little carbon dioxide, or a few drops of carbonic acid water, in order to be sure that there is a slight excess of carbonic acid present. Evaporate the solution to dryness at a temperature a little above the boiling point of water, using great care to keep out dust or dirt. When thoroughly dry transfer to a dry glass-stoppered bottle for further use. Now carefully weigh a clean $\frac{1}{2}$-oz. platinum crucible, and add to it not quite a gram of the dried carbonate of soda, ignite over a Bunsen burner until the soda is just melted and weigh. This weight gives the amount of carbonate of soda used, and is the basis of the standardizing. Have previously prepared two solutions made as follows: 1. A solution of distilled water to which has been added about 26.5 grams of concentrated C. P. sulphuric acid per litre. The solution should be thoroughly mixed and allowed to cool before using. 2. A solution of caustic potash in distilled water, made by adding to it about 50 grams of commercial stick potash per litre, allowing to dissolve, and then adding to it $\frac{1}{2}$ litre of milk of lime, made by slacking 70 grams of commercial caustic lime, and diluting with water to 1 litre. After the lime is added, boil for 10 or 15 minutes, then allow to settle and draw off with a pipette about 50 c.c. of the clear solution, transfer to a beaker, and add a few drops of phenolphthalin. Then run in from a burette some of the sulphuric acid solution above described, until the last drop just discharges the color and boil. If 5 or 10 minutes boiling does not bring back any of the pink color, the caustic potash solution may be regarded as free from carbonates and is ready to be proceeded with. If boiling does restore any of the pink color, the boiling with the lime must be continued, or fresh milk of lime added and boiling continued until the solution is free from carbonates by above test. After carbonates are proven absent, filter the solution into the vessel in which it is to be kept for use, taking care to avoid exposure to the air as much as possible. The two solutions thus prepared should be rendered homogeneous by stirring or shaking, and should then be allowed to stand until they are both of the temperature of about 80° F.; this being accomplished the strength of each in terms of the other must be known. For this purpose run from a burette 40 c.c. of the acid solution into a beaker, add a few drops of phenolphthalin, and then titrate with the caustic potash solution. Two or three tests should give same figure within one or two drops. Preserve the figures thus obtained. Now put the crucible containing the fused carbonate of soda before described into a beaker, add about 50 c.c. of distilled water, and allow to dissolve. Then add about 40 c.c. of the sulphuric acid solution above described and boil 15 minutes to remove carbon dioxide, taking care that there is no loss due to effervescence. After the boiling is finished, titrate the excess of acid with the caustic potash solution, using phenolphthalin for the indicator. The relation of the acid and alkali being known as before de-

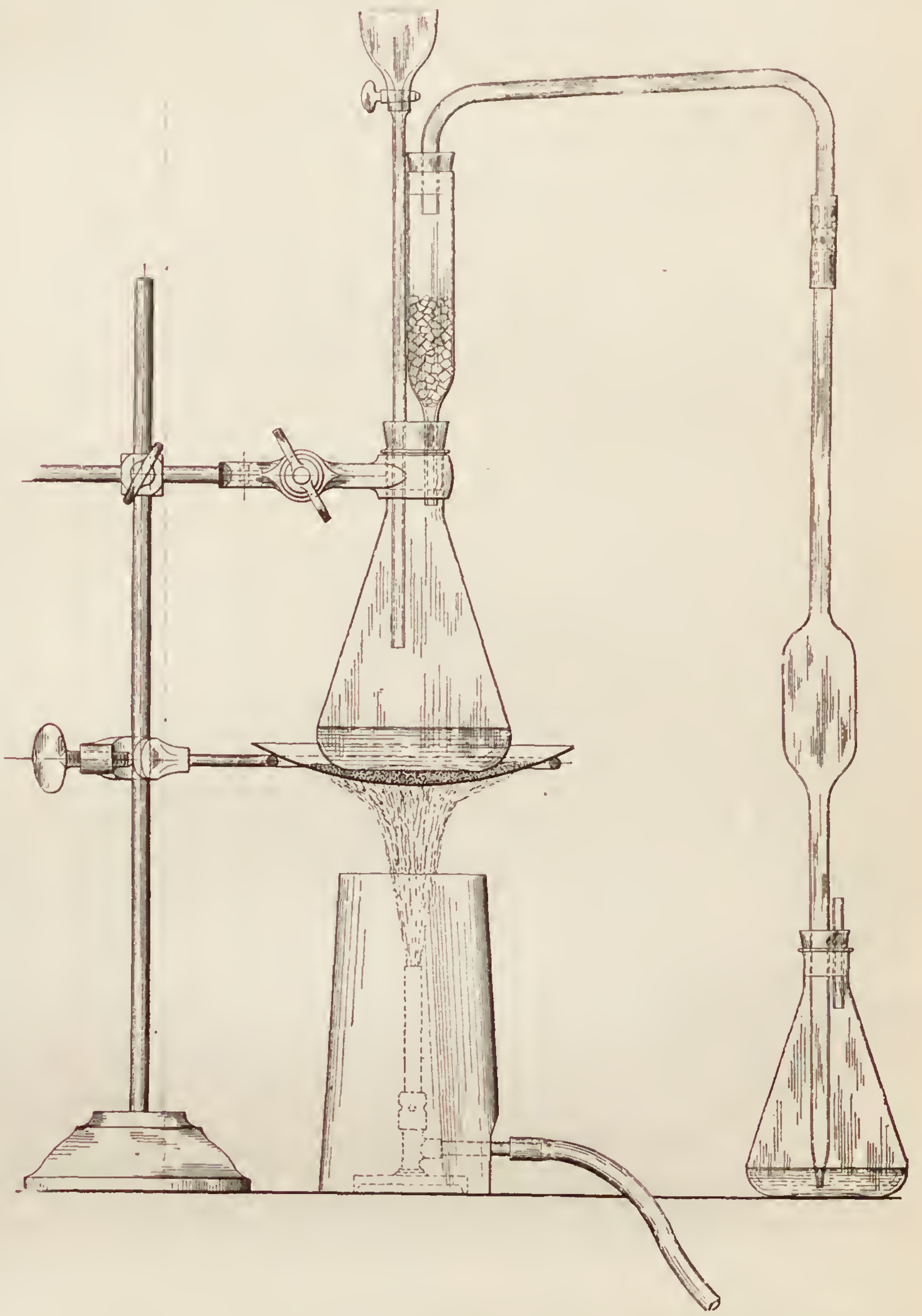
scribed, it is easy to find the amount of the sulphuric acid solution, corresponding to the carbonate of soda taken. But one point still remains uncertain—viz., whether the boiling has removed all the carbon dioxide. To decide this point add to the solution which has just been titrated with the potash solution, and which the last drop of potash rendered pink, one drop of the acid solution, or enough to just completely discharge the color and boil again. If the color does not reappear on boiling, the figures already obtained may be regarded as satisfactory. If the color does reappear, run in 1 or 2 c.c. of the acid and boil again. The amount of acid thus run in must be added to the 40 c.c. used at first. After boiling, say 5 minutes more, titrate with the potash solution, noting how much of it is required to bring back the pink color, and adding this amount to the amount of potash solution previously used. Now test as before for the absence of carbon dioxide, and if it is proven not present, find the total number of c.c. of the sulphuric acid solution which are equivalent to the carbonate of soda used. From this, as described below, the amount of sulphuric acid [H_2SO_4] in 1 c.c. of the acid solution may be obtained. But convenience in the subsequent use of the acid solution makes it desirable that each c.c. of it should contain a definite proportion of the molecular weight of sulphuric acid, say one-fourth or 0.0245 grams, H_2SO_4. If sufficiently concentrated C. P. sulphuric acid has been used in making the solution to start with, the figure obtained as above will be larger than this, and as shown in the calculation below, a certain amount of water must be added, which should be done, the solution being agitated by stirring or shaking, and then allowed to stand until the following day, when a new determination of its strength should be made by means of carbonate of soda as above described. The figure thus obtained will show whether further addition of water is necessary. When all the water needed has been added, not less than two determinations of the strength of the acid should be made by means of carbonate of soda, as described above, which duplicates should show the value of 1 c.c. to be not less than 0.0244 gram nor more than 0.0246 gram of sulphuric acid [H_2SO_4].

The standard acid having been obtained, it remains to make the caustic potash solution so that 1 c.c. equals 1 c.c. of the acid solution. For this purpose run, say, 40 c.c. of the standard acid into a beaker and titrate with the caustic potash, using phenolphthalin as indicator. If fairly good caustic potash has been used in making the solution, this operation will show that water must be added. If the operation shows that the solution is too weak, it is better to throw it away and start again, using more of the potash per litre. The figure obtained enables, as is shown below, the amount of water that must be added, to be calculated. This amount of water should be added, the solution agitated by stirring or shaking, and allowed to stand until the following day, when a new test should be made. The figure thus obtained will show whether further addition of water is necessary. After all the water has been added, not less than two tests should be made, and each of these should show that the two solutions are alike to within one-tenth of a c.c. in 40.

CALCULATIONS.

An example of all the calculations is given herewith. Atomic weights used: nitrogen, 14; hydrogen, 1; potash, 39.1; sulphur, 32. Molecular formula: ammonium chloride, NH_4Cl; ammonia, NH_3; caustic potash, KOH; sulphuric acid, H_2SO_4; water, H_2O.

I. Standardizing the sulphuric acid. Suppose that 40 c.c. of the sulphuric acid as mixed requires 36.4 c.c. of the caustic potash as mixed to exactly neutralize it, this figure having been obtained by two or three closely agreeing tests. This means that 1 c.c. of the sulphuric acid solution is equal to [36.4 ÷ 40] 0.91 c.c. of the potash solution, and that 1 c.c. of the potash solution is equal to [40 ÷ 36.4] 1.0989 c.c. of the acid solution. Next, suppose the fused carbonate of soda in the crucible weighs 0.9864 gram, and that 45 c.c. of the sulphuric acid as mixed are run into the solution of this carbonate of soda; also that after boiling it requires 9.2 c.c. of the potash solution to neutralize the excess of acid; also that it is found that the carbon dioxide is not quite all removed by the first boiling, and that 1 c.c. more of the acid is put in for the second boiling, and that after this second boiling it requires 0 4 c.c. of the potash solution to neutralize the excess of acid, and that test shows that the second boiling removed all the carbon dioxide. It is evident that 46 [45 + 1] c.c. of the acid have been used altogether, and that 9.6 [9.2 + .4] c.c. of the potash solution have been used to neutralize the excess of acid. But 1 c.c. of the potash solution is equal to 1.0989 c.c.



APPARATUS FOR DETERMINING AMMONIA IN AMMONIUM CHLORIDE.

of the acid, or 9.6 c.c. of the potash solution are equal to [1.0989 × 9.6] 10.55 c.c. of the acid solution. Hence the amount of the acid solution used up by the 0.9864 gram of carbonate of soda is 35.45 [46 − 10.55] c.c. or 1 c.c. of the acid solution is equivalent to [0.9864 ÷ 35.45] 0.027825 gram carbonate soda. But the ratio of the molecular weights of carbonate of soda [Na_2CO_3] to sulphuric acid [H_2SO_4] is as 106 to 98. Hence each c.c. of the sulphuric acid solution contains [106 : 98 :: 0.027825 : x] 0.025725 gram sulphuric acid. But, as previously stated, it is more convenient to have the acid and alkali solutions some even ratio of the molecular weight, and therefore a solution is wanted which contains [98 ÷ 4] 0.0245 gram of sulphuric acid per cubic centimetre. To obtain this water must be added to the solution in question. The amount of this is found by the following ratio, $a : b :: x : c$, in which a represents the strength of the acid as determined, in this case 0.025725 gram, b the strength of the acid desired, in this case 0.0245 gram, c the total volume of the solution we are working with, say 15000 c.c., and x the volume of the solu-

tion after the water is added, which in the case supposed is [0.025725 × 15000 ÷ 0.0245] 15750; or [15750 — 15000] 750 c.c. of water must be added.

II. Standardizing the caustic potash solution. Suppose that it is found that 40 c.c. of the standard acid requires 31.2 c.c. of caustic potash solution as made to exactly neutralize it. This means that water must be added and the amount may be found by the proportion $a : b :: x : c$, in which a represents the number of c.c. of standard acid used, in this case 40, b the number of c.c. of potash solution used, in this case 31.2 c.c., c the total volume of the solution we are working with, say 15000 c.c., and x the volume of the solution after the water is added, which in the case supposed is [40 × 15000 ÷ 31.2] 19230, or [19230 — 15000] 4230 c.c. of water must be added. The reaction between sulphuric acid and caustic potash being represented by the equation $H_2SO_4 + 2[KOH] = K_2SO_4 + 2[H_2O]$ or by weight 98 + 112.2 = 174.2 + 36, it must be remembered that, since 1 c.c. of each solution is the equivalent of the other, the actual amount of caustic potash [KOH] in each c.c. of the solution is [112.2 ÷ 4] 0.02805 gram; that is, if a solution containing any substance which reacts with sulphuric acid is so made that 1 c.c. equals 1 c.c. of the acid, the value of 1 c.c. of the solution in question may be found by writing the equation which expresses the reaction, together with the molecular weights, and dividing the molecular weight as given in the equation of the substance sought by the same figure that is required to give the known strength of the standard sulphuric acid. Further, the quotients thus obtained may be used interchangeably according to the work in hand. Thus 1 c.c. of the standard sulphuric acid, or 1 c.c. of the standard caustic potash, is equivalent to 0.02355 gram of potash [K_2O], or to 0.020 gram of caustic soda [NaOH], or to 0.0155 gram of soda [Na_2O], or to 0.0265 gram of carbonate of soda, or to 0.0085 gram of ammonia [NH_3].

III. Ammonia in ammonium chloride. Suppose, as is noted below, that methyl-orange has been used in standardizing the acid and alkali, and that 1 c.c. of acid equals 1 c.c. of alkali. Also that 6.6 c.c. of the caustic potash solution are required to neutralize the excess of sulphuric acid in the 8 oz. flask. It is evident that [25 — 6.6] 18.4 c.c. of the standard sulphuric acid have been used up by the ammonia from the ammonium chloride. But each c.c. of the standard acid is equivalent to 0.0085 gram of ammonia, consequently the ammonia in the half gram is [0.0085 × 18.4] 0.1564 gram, or [0.1564 × 100 ÷ 0.500] 31.28 per cent. If, on the other hand, phenolphthalin has been used as indicator in standardizing the acid and alkali, and it has been found, as described below, that 50 c.c. of the standard acid require 49.5 c.c. of standard potash when methyl-orange is used as indicator, it is evident that 1 c.c. of the potash equals [50 ÷ 49.5] 1.0101 c.c. of the acid. But under these conditions with methyl-orange as indicator, it would require 6.53 c.c. of potash to neutralize the acid left in the flask in the case supposed above, or [6.53 × 1.0101] 6.6 c.c. of the acid are neutralized by the potash, showing as before [25 — 6.6] 18.4 c.c. of the acid neutralized by the ammonia; the remainder of the calculation is as above.

NOTES AND PRECAUTIONS.

It will be observed that this method separates the ammonia from the ammonium chloride by decomposing it with caustic potash, removing it from the solution by boiling and catching the ammonia gas along with some of the condensed water in standard sulphuric acid solution, no special condenser or aspirator being required.

If the boiling is conducted too rapidly, some of the water on the glass beads or balls is apt to be carried along mechanically, and may find its way into the acid flask. This water is principally condensed steam, but may contain some of the potash solution mechanically carried along from the boiling solution below. The error introduced by any of the potash solution getting into the acid solution is obvious.

On the other hand, if the boiling is too slow, especially toward the last of the operation, when the whole apparatus is filled with steam and the acid has become somewhat warm, or if a cold draft of air strikes the apparatus, there is a tendency for the acid to be sucked back toward the alkali flask. The 100-c.c. pipette allows all the acid to be sucked up into the bulb without any of it getting back into the alkali flask, but there is danger of error if air is allowed to bubble back through the acid solution in the bulb, since some of this solution may be carried mechanically by the air bubbles back into the alkali flask. By having the apparatus in a quiet place, and managing the heat properly, the absorption of the ammonia takes place quietly and there is no regurgitation.

After a test has been finished it is essential to wash out the whole apparatus and to remove the glass stopcock in the funnel tube, otherwise this stopcock becomes fast.

Much of the phenolphthalin of the market apparently contains something which combines with alkali, without showing change of color. If this is not satisfied with alkali as directed, the reaction will not be quite so delicate.

Standard sulphuric acid solution is made by adding to a clean clear glass 5-gall. bottle 15 litres of distilled water, and then weighing out and adding to it 397.5 grams of concentrated C. P. sulphuric acid. It is better to set the water in the bottle in motion by stirring with a clean glass rod before adding the sulphuric acid. After the acid is in it is essential to agitate thoroughly by stirring and shaking, but not advisable to draw air through for this purpose, as this causes the liquid to take up carbon dioxide, which interferes with its subsequent usefulness with phenolphthalin. It is not desirable to standardize on the same day, both on account of temperature, and also because it is very difficult by any practicable method of agitation to get so large a bulk of liquid entirely homogeneous without standing. If the first standardizing shows that it is essential to add, say, 750 c.c. of water, it is better to add only 700, since the liquid should be standardized once more any way, and too much water must of course be avoided. The second addition of water is usually less than 100 c.c. Both agitation and standing over night are essential after each addition of water.

Caustic potash solution is made in the same kind of bottle and in the same amount as the acid solution. The same precautions should be taken in regard to stirring, and allowing to stand over night, as in the case of the acid. It is well known that caustic potash solution, if properly made as above described, contains a small amount of caustic lime in solution. Of course this lime will appear in the comparison with the standard acid. If now the water used in the first addition contains a little carbon dioxide, a little of the lime will be precipitated on standing over night and weaken the solution a little. It is therefore not advisable to add quite as much of the water shown by calculation the first time, as in case of the acid.

The two solutions, as will be observed, are made in quite large amounts, and considerable pains are taken to have them right, since other work depends upon them. Both of the solutions are kept on a shelf somewhat higher than the burettes, and both are drawn into the burettes by means of glass tube syphons with glass cocks at the lower ends. In accurate work it is of course essential to draw out and throw away the liquid which has been standing exposed between the cock and the lower end of the syphon tube before filling the burette. The air which goes in to replace the liquid in the large glass bottles should bubble through caustic potash solution in order to keep out carbon dioxide. Potash bulbs are used for this purpose.

The fact that phenolphthalin is sensitive to carbon dioxide in water solution and to carbonates and bicarbonates may lead to serious error unless sufficient care is taken to add enough acid to decompose all carbonates and bicarbonates and then expel the gas by boiling before subsequent titration with caustic potash. An illustration will make the matter clear. Let us suppose that in obtaining the relation between carbonate of soda and sulphuric acid in standardizing the acid, the carbon dioxide is not quite all removed by boiling, when we attempt to measure the excess of the acid by means of the caustic potash solution. We add this solution drop by drop and ultimately reach a point when all the free sulphuric acid is satisfied with the caustic potash, but since phenolphthalin in presence of carbonic acid or carbon dioxide in water solution does not change color until part at least of this carbonic acid is also satisfied with caustic potash, we do not get our end reaction when the sulphuric acid is all satisfied, as should be the case, but rather after some further addition of caustic potash. The error is obvious, and there is always uncertainty if carbon dioxide or carbonates are present when using phenolphthalin as indicator. Even carbon dioxide in the standard sulphuric acid solution, or carbonates in the caustic potash solution, will cause difficulty. Possibly other indicators do not give so much trouble from this cause, but all that we have ever tried are so much less sensitive and sharp at the end reaction than phenolphthalin, provided the conditions are right, that we prefer to take the extra trouble. Positive experiments show that if the solution is rendered clearly acid with standard acid, and boiled for 10 minutes or even less, the carbon dioxide will all be expelled, so that if the directions are closely followed, the results will be fairly accurate. It is obvious that if the distilled water used in making the standard acid contains carbon dioxide, there will always be some present, with a consequent liability to uncertainty in the final results. Presence or absence of carbon dioxide in the standard acid can be proved by titrating some of the acid cold with

standard caustic potash, using phenolphthalin as indicator and then titrating another similar portion after it has been boiled. If carbon dioxide is absent, the two tests should show the same figure. If it is present in injurious amount, it will be essential to always boil to expel carbon dioxide in all tests where this acid is used before attempting to titrate in presence of phenolphthalin.

It is well known that all indicators do not show the same end reaction, all other conditions being the same. If methyl-orange is used in standardizing the acid and alkali, the precautions in regard to carbonic acid may be ignored. If phenolphthalin has been used in standardizing the acid and alkali, it is essential, in order to use these solutions in this method, that the value of 50 c.c. of the standard acid should be obtained in terms of the standard potash, using methyl-orange as indicator, since, the indicator being changed, the ratio of acid and alkali will not be quite 1 to 1. Of course the value thus found should be used in the calculations as shown. Phenolphthalin is so much more sensitive than methyl-orange that it is recommended to standardize with the former, since it is quite essential to know pretty accurately the strength of the standard acid.

The reason for using methyl-orange as indicator is that phenolphthalin is unreliable in presence of ammonia salts.

Burettes may be satisfactorily calibrated by filling them with distilled water at temperature at which they were graduated, and then drawing out into a flask and weighing each 5 c.c. to the bottom, and then fill again and start 1 c.c. lower down, and proceed as before. Two or three times through in this way will check any discrepancies that will seriously affect the result. Of course, each 5 c.c. should increase the weight the same amount, and if the burettes are fairly well graduated the differences should not be over the weight of one drop, approximately 50 milligrams. Obviously by using a good balance and going through the burette times enough, the calibration can be made as fine as the graduation. It is hardly necessary to add that the burette used for acid during the standardizing, also the one used for potash during the standardizing, must always be so used, or if it is desired to use them interchangeably they must be exactly alike.

It is well known that change of temperature affects all volumetric work, and it is equally well known that there is no error from this cause if the solutions are used at the same temperatures at which they are standardized. Standard solutions may be kept on a shelf near the ceiling of the room where the temperature is about 80° F. They should be standardized finally after they have been at this temperature over night. With most of the determinations for which these solutions are used, a change of temperature of 10° F. does not introduce a greater error than would be produced by one drop of the solution. Of course, in very fine work care should be taken to use the solutions at the temperature at which they are accurate.

AERIAL RAILWAYS.

The single-rope bridges of the Himalayas and the Thibetan frontier are probably one of the oldest and simplest engineering devices known. A rough rope, sometimes made only of twisted birch twigs, is fastened across the chasm of a mountain torrent, and round this is hung a hoop. In this the passenger sits, and hauls himself across by hitching the hoop forward as he holds the rope above with his hands. The only development of this primitive system was the addition of a second rope—an endless cord—by which the passenger in the hoop was drawn across from either side, with no more risk than was involved in the task of keeping himself from falling out of the hoop in which he sat. Some such rough form of transport, with buckets and wheels substituted for the hoop, was used for many years in the lead mines of the Peak of Derbyshire ; but if hemp had remained the strongest material for rope-making, the aerial railway would never have taken the place which it has, or attracted the attention which it now claims, among the practical means of cheap transport.

The invention of the twisted steel rope has made the development of the aerial railway practically safe and commercially possible, and more than 2,000 miles of line are now in working order in Spain, Italy, South America, India, the Cape, China, and Japan. To "over-seas Englishmen" the cable-way at Hong Kong is as well known as the "Devil's Dike" Line will soon be to London visitors to Brighton. It shares with the latter the distinction of being the only aerial line used solely for passenger traffic, though it was built for useful and commercial reasons. It was found necessary to transport all European workmen in the port up the mountain every night, in order to sleep in purer air, and the cheapest and quickest means was found to be the construction of a "Telpher" line. The saving in time alone is said to have already repaid the cost of its construction. Nothing could be simpler than this Hong Kong line. It is carried straight up the mountain side, the endless line stretching from ravine to ravine, on high steel trestles, through which the little back-to-back cars run on the rope like a section of the "knife-board" of an old-fashioned omnibus. Three passengers sit on each side ; and though the height at which they travel must be trying to the nerves, they are not shut in by aprons of steel wire, as in the case of the Brighton cars. An awning, for protection from the sun, is the sole addition to the minimum of accommodation provided on this airy journey. The length of the line is 2 miles, and the exact height ascended 1,090 ft. The Chinese population of Hong Kong were much disturbed by the invasion of the mountain by this railway. They attributed the epidemic of the plague to the anger of the mountain demons, who were prevented by the wires from making their nightly flights round the circuit of the hill.

The difficulties in the construction of the Table Mountain wire line were far greater than in that at Hong Kong. A precipice and incline of 800 ft. in height interrupted the ascent midway. The summit of this precipice was used as a support, and the suspending wire leaped in a single span of 1,470 ft. to the edge of the cliff, and from thence in another span of 1,400 ft. to the flat top of the mountain. The loads carried across these gulfs average half a ton each, and the line is used both for passenger and goods traffic. The rock of Gibraltar has also its wire line, though of slighter build, and far more striking steepness. The height to the signal station is barely a quarter less than the total length of the line, and the wire runs straight to the summit on a series of lofty trestles, after a first leap of 1,100 ft. in an ascent of 1 ft. in every 1½ ft. Viewed against the sky, looking parallel to the mountain side, it looks like a telegraph wire stretched tight from the tops of a series of little Eiffel towers ; yet the soldiers ascend and descend in the little wooden boxes which travel on it with equal safety and comfort. The Hong Kong, Gibraltar, and Table Mountain lines are worked on a double cable along which one car ascends as the other descends, the two being connected by a hauling rope.

But these are toys compared with the complicated and ever-increasing system of aerial trains now working in the great iron mines of Spain. Near Bilbao the greater part of a mountain side is quarried away at different levels to obtain the fine iron ore, which is carried to the railway by nine lines, running from the station at the foot of the mountain to the mines along the summit. These nine lines carry on an average 2,300 tons of ore a day, none of which touches the level of the ground till it has travelled some 5 miles through space. The appearance of these multiplex lines of wire stretching from tower to tower of light-trellised iron, and hung at intervals with hundreds of ore carriages in constant motion, is one of the strangest spectacles in modern mining enterprise. The double line of iron scaffolds, where it leaves the terminus in the valley, looks like the support for some enormous viaduct, festooned with wires slung with rows of pendent buckets. Higher up the mountain, where deep ravines cut the face of the hill, the trestles tower to such a height that the traveling loads of ore look like little black balls against the sky. When the different levels of the mine are reached, the lines of the wireway diverge, and are carried to nine separate points in the workings.

Yet the traffic is controlled with little difficulty, and there is no risk of any serious stoppage by accident, as in the case of a breakdown on the trunk lines of a great railway. At the worst, one or two lines only would be blocked, leaving the others free for use. It is calculated that 100,000 tons of ore can be carried on each of these cables before it becomes unfit for service. In crossing wide ravines or rivers where one bank is lower than another, the aerial line is used exactly as the old-fashioned funicular railway works, the descending load being used to haul up the ascending car. In the Alps, the Pyrenees, and in the bridging of deep river-beds, this is the simplest and cheapest form of transport known. In the Italian Alps a span of 1,500 yds. is crossed without a support, and this "gossamer" transport is soon to be applied to distances of 2,000 yds. The usual means of drawing the load on level lines where it is not carried by the force of gravity is to revolve the endless cord by a drum worked by steam. But a recent and ingenious invention promises a further development of aerial lines. The steel rope is charged with an electric current, and the cars themselves carry a motor which "picks up" its power as it travels along the wire.—*London Spectator.*

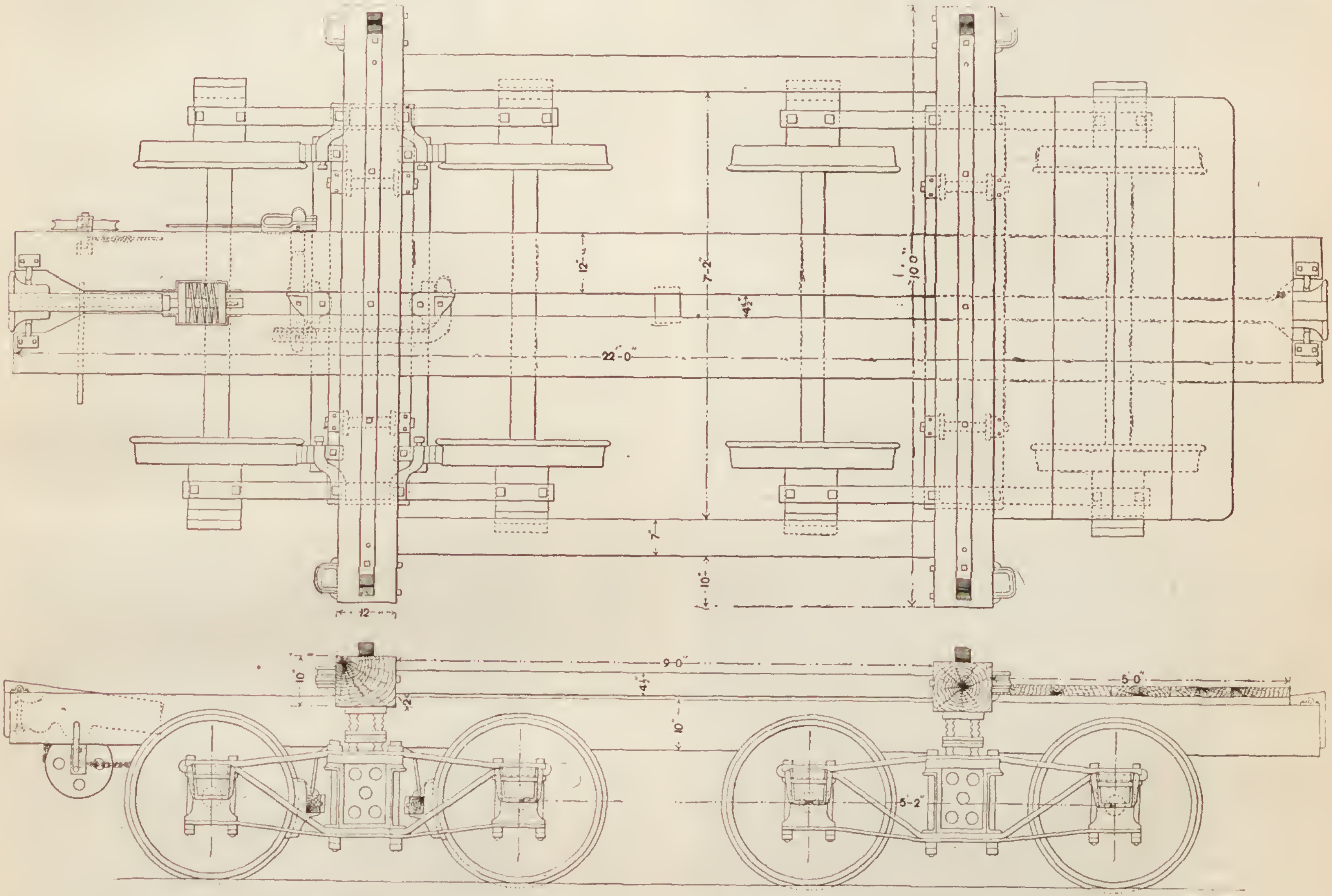
CRIB TRESTLE ON THE LOGGING RAILROAD ON THE PROPERTY OF THE J. E. POTTS LUMBER CO.

LOGGING RAILROADS.

When the pineries of the Northwest were standing in all of their primitive grandeur and extent, the work of their devastation was naturally carried on close to the banks of the rivers and streams that afforded an easy and natural highway for the transportation of the logs to the mills, where it was to be sawn; but the day came when the timber had been cut off to such a distance back from the streams that it became difficult to obtain a sufficient supply to meet the demands of the mills that were in operation along the lakes and in the river towns. Therefore, if these mills were to be kept running at the rate of which their machinery was capable, the material must, of necessity, be brought from points further inland. To do this with horses was a work of such magnitude that it could not even be considered, so the logging road was developed, and locomotives and cars of special construction were designed to meet the demands, and were quickly substituted for the truck and sled hauled by horses.

In a few years this log-carrying trade developed into a business of great magnitude, though it has fallen off very considerably as the depletion of the forests have been carried forward to what might be called completion. At one time the whole of the pine-bearing portion of the southern peninsula of Michigan was pretty thoroughly netted with logging railroads of one description or another. These roads varied from the branches of the main lines of traffic, upon which regular trains were run for passengers and miscellaneous freight, or through the several grades of branches, spurs, private lines and mill sidings. The larger branches presented no novel or peculiar features, and were usually constructed with a view to a permanence that would in the future be suitable for regular railroad work. Starting out from the branches at such intervals as the convenience of the property owners might indicate were a number of spurs of 1, 2 or 3 miles in length, and intended for the special use of these owners. They were usually surveyed and graded at the expense of the firm owning the standing timber, while the rails were laid by the railroad to which the spur was tributary. These surveys were necessarily made with haste, as the idea was not so much to select the best as a possible location. The usual method that was pursued was for the company's engineer to go over the ground, and in a hasty manner select the general course of the road, and at the same time gather a tolerably correct idea of the topography of the country. A sketch of the desired line would then be laid down on the section map, and a preliminary line run and the levels taken; then, if the result came within the prescribed limits of grades, curves and excavations, the work would be handed over to the contractor. If the spur were to be tributary and the logs were to be sent over the main line, the grades would be limited to 200 ft. to the mile, and the curves to 12°; but if the line is operated by engines belonging to the owners of the property, and the cars are the open rack logging cars, these curves and grades are greatly exceeded. We have seen cases where the grades have risen to as much as 290 ft. to the mile, and the curves to 18°. In such cases as this the Shaw locomotive is usually employed, and this machine, with its flexible wheel-base, has shown itself to be especially well adapted for squirming and twisting in and out among the trees, until it would seem to be possible to drive it wherever a tote wagon could be taken. Our illustration, on page 76, shows one of these engines hauling a train of loaded logging cars over a timber trestle on the property of the J. E. Potts Lumber Company. This particular trestle has a length of 1,700 ft. and an average height of 35 ft., and contains several million feet of logs.

As these lines are of a temporary character, the grading is done as hastily as the survey, and not a shovelful of earth is moved that the necessities of the case do not demand. The fills are rarely more than 10 ft., and we have never seen them more than 12 ft. wide, while the cuts are from 12 ft. to 14 ft. wide, with banks as steep as they will stand. Not a stump is pulled or a tree cut down that is not actually in the way, and such things have been known as a cut of from 6 ft. to 8 ft. in depth, with banks rising two in one, and a pine-tree 100 ft. high standing on the very edge, with the roots half cut away to allow the cars to pass. On such a road ballast is supplied only as far as it is actually required to hold the ties in place, and it is somewhat odd to see a heavy locomotive working its way over such a road, where in places the branches of the trees meet overhead. While collisions are not to be feared,



LOGGING CAR IN USE ON THE FLINT & PÈRE MARQUETTE RAILROAD.

FIG. 9.

FIG. 10.

FIG. 11

FIG. 12

VIEWS DURING CONSTRUCTION ON THE WESTERN SIBERIAN RAILWAY.

the operation of these roads is a matter that requires the utmost care on the part of the trainmen, especially in the winter. The grades are steep, the track curved and uneven, and with a load of from 20 to 25 heavily loaded flat cars, piled with logs and perhaps covered with ice and snow, and ready to slide from their places on the slightest provocation, the engineer has to use all of his skill to get out to the main line. In what has been said we do not wish to convey the idea that the work of construction is not substantially done; it is merely cheaply done, for the operators do not have to regard the matter of future cost of operation, since the rails will be torn up and used elsewhere as soon as the timber is cut, and where the roads are worked by private concerns the cost of fuel is an item of no account, as the engine will burn the refuse of the mill.

Frequently the roads will be surveyed and built by the foreman of the mill, with no other instruments than a tape-line and a few axes and shovels. Such work as this is, however, the exception, and is apt to result in bent rails to such an extent that there will be no economy in the long run.

The railroad companies that have catered to the logging trade have not departed from the ordinary standards of locomotive construction, and have found the mogul to be the most serviceable for the work. The cars, on the other hand, have been especially designed for the traffic. At first the regular flat car was employed, but it was found to be too high for convenient loading, and the brake staffs were in the way. They were bent and twisted by the logs in the loading, and frequently so hedged in that the trainmen were unable to get at them when brakes were called for. The first change that was made was that of lowering the sills and running the draft-rigging in through the end sill. At the same time the brake-staffs were done away with, and the brakes were applied by means of a chain rove over a wheel beneath the floor and caught by a dog when it was pulled up. It was very rarely that these chains were inaccessible, and this method of applying the brakes has proven reliable and satisfactory.

These modified cars were of the regular length of about 34 ft., and on them two tiers of logs of 16 ft. lengths were loaded. This was not entirely satisfactory, and the car illustrated on page 77 was designed for the work. It is the car that is now in use on the Flint & Père Marquette Railroad. It is a substantially built, open framework, resting on bogie trucks that are 9 ft. between centres. The whole framing of the car consists of two heavy bolsters of 10 in. × 12 in. timbers, held together by four sills. The outside sills are 4½ in. × 7 in., and the centre sills are 10 in. × 12 in. These latter extend out to the ends of the car, and serve as dead woods as well as for the attachments of the draft-rigging. The bolsters are protected by an iron plate from the wear of the logs, and at each end there is a stake pocket. The standard trucks are used with the usual brake attachments. These cars are not only less expensive in their first cost, but are lighter and more easily handled in the woods than the flat cars, and will probably hold their own until the forests entirely disappear, which does not seem now to be a matter of the remote future.

RUSSIAN ENGINEERING NOTES.

LAUNCH OF NEW RUSSIAN ARMORED SHIPS.

On November 7, 1894, a new Russian armored battleship, the *Poltava*, was launched from the yard of the New Admiralty in St. Petersburg.

The dimensions of the armored ship *Poltava* are less than those of the armored ship of the Black Sea fleet, the *Tri Swiatitela*. The extreme length is 375 ft.; breadth, 70 ft.; displacement, 10,960 tons. The propeller consists of two screws cast from aluminium bronze. The triple-expansion engines furnish 10,600 I.H.P. The speed of the ship will not be less than 17 knots. The ship is protected with armor plates 16 in. thick amidships, and about 8 in. at the bow and stern. The total weight of the armor is 2,848 tons, or 26 per cent. of the whole displacement. At present the launched hull weighs only 4,600 tons, or 42 per cent. of its displacement.

The armament of the ship will consist of four 12 in. guns, eight 8 in. guns, ten 1-lb. and fifteen 5-lb. Hotchkiss guns, and two Baranov guns. The ship is covered with an armored deck and carries two turrets, each with two 12-in. guns.

The torpedo armament consists of 6 submarine apparatus and 50 sphero-conic torpedoes, in addition to which there is a set of protecting nets.

The keel was laid March 9, 1892. The whole hull is made of Russian materials and by Russian engineers and workmen. The engine was ordered in England from the firm of Messrs. Gumfreis, Tennant & Company, which delayed the execution of order six months.

On November 9, 1894, a new Russian armored battleship, the *Petropavlovsk*, was launched from the slip of Galerny Isle, in St. Petersburg. The dimensions and construction of the ship are the same as of the armored ship *Poltava*, launched a few weeks later from the slip of the New Admiralty in St. Petersburg. Both were dedicated by the late Emperor Alexander III. on May 7, 1892. Only one battleship of those designed now remains on the stocks—viz., the *Sebastopol*. She is being constructed at Galerny Isle, St. Petersburg, and will be launched next spring.

In the past year four Russian armored ships were launched: the *Admiral Seniavin*, *Sysoï the Great*, *Poltava* and *Petropavlovsk*.

In the New Admiralty, in St. Petersburg, the construction of a new coast-defence armored ship, the *General-Admiral Count Apraxin*, has been commenced; and at the yard of Galerny Isle, St. Petersburg, the construction of a high-speed ocean cruiser is also projected. This cruiser will be of the same type as the cruiser *Russia*, with three screws, now in construction at the Baltic Works.

Besides these in the New Admiralty yard the construction of an armored battleship of the type of the *Sysoï the Great* is projected.

In the spring of 1895 a series of launches is expected, and the Russian fleet will be increased by a number of new gigantic ships.

The *Petropavlovsk* is named from Port Petropavlovsk, in Kamchatka, on the Pacific.

VIEWS ON THE WESTERN SIBERIAN RAILWAY.

On the opposite page another series of four views, from the interesting photographs received from our correspondent in Siberia, are given, showing the progress of this great work.

Fig. 9 shows an ordinary piece of earthwork.

Figs. 10 and 11, earthwork in cutting a new channel for the Tabol River near Kourkan.

Fig. 12, track-laying.

These views give some idea of the character of the country through which this road is built; and the portion shown in these and others indicate that it resembles very much that of our Western prairies. They also show the force of men which has been and probably still is employed in carrying this new line across the continent of Asia. What its influence will be on both European and Asiatic polity and civilization when completed no one can even vaguely predict.

THE HISTORY OF THE FOUR-WHEELED "BOGIE" ENGINE.

The following interesting history of the "bogie" engine has appeared in the *English Mechanic*, and is from the pen of Mr. Clement E. Stretton, C.E., and will interest many of our readers:

"There are few subjects connected with the history of the locomotive engine which have at various times engaged more attention, or have caused so much acrimonious discussion, than the history of the 'bogie engine,' and more especially the question as to whether the credit for its introduction belongs to England or to America.

"The writer, viewing the matter simply from the position of an impartial, independent historian, has not accepted the claims or statements of either side, but has fully investigated the whole of the reliable evidence and official records with the following results.

"As early as the year 1800 the Merthyr-Tydfil tramroad was opened in South Wales, and in order to convey long bars of iron, and also timber, wagons were constructed in pairs coupled together by an iron drawbar having a joint at either end. These wagons had no sides, but in the middle of each there was fixed a centre pin upon which worked a cross-beam or 'bolster,' upon which the timber or bars of iron were placed. Of course, it will be at once seen that these early

wagons were not actually 'bogie' vehicles, and that they were in use before even the first locomotive engine had ever run upon rails; yet we cannot upon examination fail to see that they contained all the essential principles of the 'bogie.' They allowed a very long load to be conveyed round sharp curves, and permitted the wheels under the two trucks to follow the curve of the rails. Now, the most improved 'bogie' vehicles of to-day simply carry out the very same principle. There can be no question as to the practical value of these early 'bogie' wagons, when it is mentioned that some of them were in use from 1800 to 1875, and that two of them were sent from South Wales to the Chicago Exhibition of 1893.

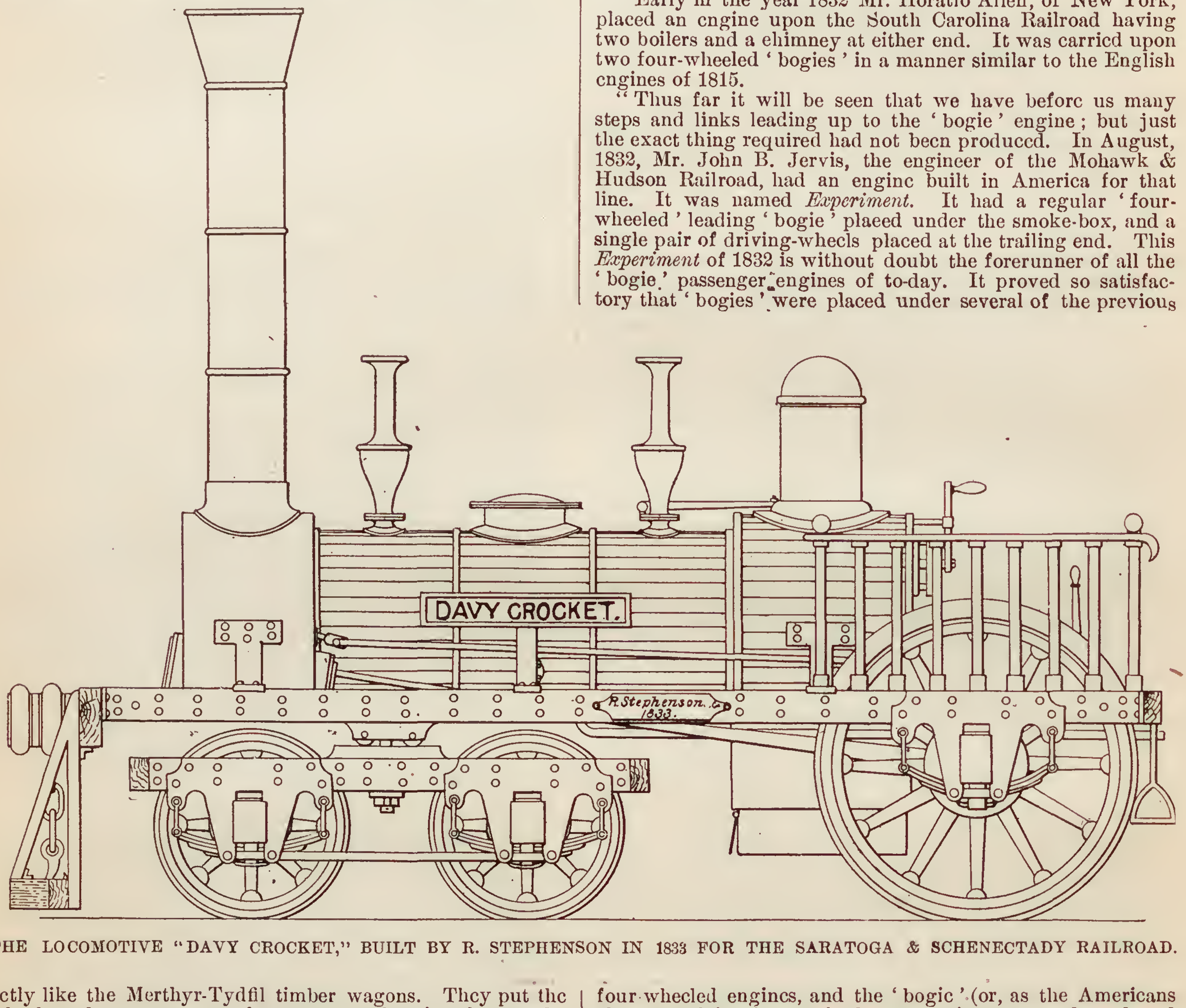
"In 1813 Blackett & Hedley constructed two engines for working on the Wylam Colliery Line, near Newcastle-on-Tyne. The first of these was named *Puffing Billy*, the second *Wylam Dilly;* they both ran upon four wheels and were successful so far as conveying coal cheaper than by H.P.; but their weight broke the cast-iron plate rails to such an extent that it became necessary to carry half-a-dozen rails upon each engine, to replace those which might be broken during the journey. To prevent the breaking of the rails Blackett & Hedley placed each engine upon eight wheels, arranged exactly like the Merthyr-Tydfil timber wagons. They put the wheels under two separate frames or trucks; in other words, they placed their engines upon two four-wheeled 'bogies' in the year 1815. These two double 'bogie' engines worked successfully from 1815 to 1830, when the railway was relaid with stronger rails; flanged wheels were employed, and the engines were again returned to four wheels; and one of the engines is now preserved at South Kensington Museum, and the second at the Edinburgh Museum.

"Now here we have ample proof that two engines, each having two four-wheeled 'bogies,' were actually at work in England for 15 years, *before* 1830, and before any 'bogie' engine had been tried in America or other part of the world. On the other hand, it will be seen that the English abandoned the use of the 'bogies' on these engines in 1830, and therefore that they either did not observe or did not appreciate the value of the 'bogie,' for it will be found that the celebrated *Rocket*, *Planet*, and other engines of the period had the rigid wheel-base.

"During the year 1831 Messrs. Stephenson & Co. sent out four engines to America, named *Whistler*, *Delaware*, *John Bull* and *Stevens*, which had its name changed to *John Bull*. Mr. Bury, of Liverpool, also sent his well-known *Liverpool* of 1831; but experience quickly proved that the American railways were not so strongly laid as were those in England, for engines which were satisfactory in this country were in the United States found too heavy, or had difficulty in passing round very sharp curves. The engine *Stevens, John Bull*, running upon the Camden & Amboy Railroad, was within a few weeks of its arrival fitted by the Americans with an extra pair of wheels in front, attached to a swivelling frame—in other words, a two-wheeled pony truck; and it is a matter of much interest that this old engine has been so well preserved in working order, that at the commencement of the Exhibition of 1893 it ran in steam with its train from New York to Chicago, a distance of 913 miles—a remarkably good performance for an engine 62 years of age.

"Early in the year 1832 Mr. Horatio Allen, of New York, placed an engine upon the South Carolina Railroad having two boilers and a chimney at either end. It was carried upon two four-wheeled 'bogies' in a manner similar to the English engines of 1815.

"Thus far it will be seen that we have before us many steps and links leading up to the 'bogie' engine; but just the exact thing required had not been produced. In August, 1832, Mr. John B. Jervis, the engineer of the Mohawk & Hudson Railroad, had an engine built in America for that line. It was named *Experiment*. It had a regular 'four-wheeled' leading 'bogie' placed under the smoke-box, and a single pair of driving-wheels placed at the trailing end. This *Experiment* of 1832 is without doubt the forerunner of all the 'bogie' passenger engines of to-day. It proved so satisfactory that 'bogies' were placed under several of the previous four-wheeled engines, and the 'bogie' (or, as the Americans always call it, the truck) has ever since been adopted and used in the United States. In 1833 Messrs. Stephenson & Co. constructed an engine named *Davy Crocket* for the Saratoga & Schenectady Railroad. This engine had a leading 'bogie' and single driving-wheels, and was almost exactly similar to the *Experiment* of Mr. Jervis. Some persons have stated and claimed that the English *Davy Crocket* was built to the order and design of Mr. Jervis; others have maintained that it was designed at Newcastle. This point, it will be seen, is of practically no importance in the chain of history, for when it is proved that the first engine of the class was built in 1832, it matters but little who built an almost exact copy of it about a year later.



THE LOCOMOTIVE "DAVY CROCKET," BUILT BY R. STEPHENSON IN 1833 FOR THE SARATOGA & SCHENECTADY RAILROAD.

"During the time that Stephenson was building the *Davy*

Crocket and some other *leading* 'bogie,' engines for America, Messrs. Carmichael & Co., of Dundee, were busy constructing three engines for the Dundee & Newtyle Railway in Scotland. These engines had a single pair of driving-wheels placed in front, and a four-wheeled 'bogie' at the trailing end. The first of these engines was named the *Earl of Airlie*, and was put to work in September, 1833. These three locomotives were consequently the only ones working in Great Britain with a 'bogie.'

"When the Birmingham & Gloucester Railway was opened it was found that no English engines could run up the Lickey incline of 1 in 37. Eight American engines were therefore supplied, in 1840, by Norris & Co., of Philadelphia. They all had the leading 'bogie' and a single pair of driving-wheels, and were then the only *leading* 'bogie' engines in this country.

"Until the year 1874 it may be said that the 'bogie,' either for engines or carriages, found very little favor in this country; but in that year the introduction of American Pullman-car trains upon the Midland Railway proved to all impartial persons that 'bogie' coaches ran far more steadily than either four or six-wheeled English vehicles.

"About the year 1876 several of the English railways constructed express engines with leading 'bogies,' and this pattern has gradually become more and more popular and successful, until now it may be said that the 'bogie' has been adopted by nearly every line of importance in Great Britain except the London & Northwestern.

"From the particulars above given, it will be apparent that the 'bogie' had its origin in England, but that its general adoption for passenger engines commenced in America in 1832, and that between the years 1876 and the present time the 'bogie' has been brought back, so to speak, to this country, and now it is easy to see that very few more passenger engines will be built in Great Britain without a 'bogie.'

"CLEMENT E. STRETTON, C.E.

"LEICESTER, December 13."

Mr. Stretton, as the readers of THE AMERICAN ENGINEER are aware, has been an indefatigable investigator into the history of the locomotive, and it has been through his efforts that much that has been interesting has been rescued from oblivion. In his excellent book on the "Locomotive Engine and its Development," he has given an engraving of the *Puffing Billy*, which it is said Hedley placed on two four-wheeled trucks in 1815. This illustration has been published often heretofore, but it does not seem entirely certain from the engraving that the two groups of four wheels, at each end of the engine, could move about a centre pin as an ordinary truck does. It has often been stated that they did, but from the engraving alone it is thought there is equally as good evidence for inferring that they did not. It is hoped that Mr. Stretton may be able to obtain some more conclusive evidence with reference to this point than has thus far been quoted.

That the invention of the "bogie" or truck was almost contemporaneous with that of railroads themselves has often been shown, and the discussion of the question, whether it originated on this or the other side of the Atlantic, is a matter of not very much importance. That the "bogie" system would suggest itself wherever four-wheeled cars were used without any invention is obvious, and that it was evolved in that way in the early days of railroading, both in England and in this country, has often been shown. In the celebrated Winans eight-wheeled car case it was proved that "bogie" cars had been used on the Quincy Granite Railroad in Massachusetts as early as 1829, and that in the early days of the Baltimore & Ohio Railroad it was a common practice to load fire-wood on two four-wheeled cars by placing a bolster on each, connected to the car by a centre pin, and then adding long timbers attached to each of the bolsters. The fire-wood was then laid crosswise on the timbers. An English patent granted to W. and E. W. Chapman in 1812. The specification was published in the 24th volume of the Repertory or Repository of Arts, etc., in February, 1814, with drawings. The latter shows a carriage of six wheels for the engine, which the patentees say "may rest equally, or nearly so, on each of its wheels, and move freely round the curves or past the angles of a railway; the fore pair of wheels are, as usual on railways, fixed to the body of the carriage, and the other two pair are fixed on axles (parallel to each other) to a separate frame, over which the body of the carriage should be so poised as that two-thirds of its weight should lie over the central point of the fore wheels where the (pivot ?) 4 is placed, and the remaining third over the axis [axle] 1, 1. The two-thirds weight of the carriage should rest on conical wheels or rollers bearing upon curved plates, so as to admit the ledges of the wheels or those of the way to guide them on its curves or past its angles, by forcing the transom or frame to turn on the pivot, and thus arrange the wheels to the course of the way, similarly to the carriage of a coal wagon;" and the patentees add, "If the weight of the locomotive engine should require eight wheels, it is only requisite to substitute, in place of the axis [axle], a transom such as described, laying the weight equally upon both, and then similarly to two coal wagons attached together, the whole four pair of wheels will arrange themselves to the curves of the railway."

In the same trial it was shown that the drawings for the eight-wheeled, double-truck locomotives, designed by Mr. Horatio Allen, and built for the South Carolina Railroad, were made in 1830 and 1831, and the engines were put in operation in 1832. Mr. Jervis testified that in the latter part of the year 1831 he invented a new plan of frame, with a bearing carriage for a locomotive engine, and that an engine was constructed on this plan in 1832. It will be seen that Mr. Stretton states that in 1833 Messrs. Stephenson & Co. constructed an engine named the *Davy Crocket* for the Saratoga & Schenectady Railroad. A blue print from a drawing of this engine has been received from him, and is reproduced herewith. It would be interesting to know whether the plan of this engine was adopted on the suggestion of Mr. Jervis, or whether, as has been claimed, it was designed in Newcastle.

Mr. Stretton has given us a very interesting *résumé* of this history, which has been the subject of a good deal of warm discussion.

REPORT OF THE BOARD OF RAILROAD COMMISSIONERS OF THE STATE OF NEW YORK.

ADVANCED copies of the report of this Commission for the year 1894 have been received. Of the

GENERAL SITUATION

the commissioners say: In the report of last year the Board declared the railroads to be struggling for existence. This condition, it was pointed out, was not peculiar to them nor to any class of enterprises, but was common to a great mass of associations, institutions and individuals. The business history of the past twelve months has verified this view beyond the belief of the Board at the time of its publication. During that period, excluding persons receiving salaries, wages, or similar forms of remuneration, it is not to be questioned that the vast majority of the citizens of this State, and of the whole Union, has subsisted, consciously or unconsciously, out of capital or of previously accumulated wealth. The income of the people has been curtailed almost beyond precedent. It has been a period of expedients, of hope deferred and of protracted trial. It is not yet possible to see the end. The continuous recurrence of a deficiency in national finances, with no sure promise that the conditions producing it are to be reversed in the near future, is typical of the situation in many quarters of the business field. Unprecedentedly low prices discourage and cripple producers. Unprecedentedly small shipments from producers discourage and cripple carriers. Manufacturers, traders and middlemen find little or no margin of profit on which to exercise their activities. The pressure of such a season, when too greatly prolonged, deadens the co-operative spirit, without which the mechanism of society ceases to be efficient.

The community thus becomes nervous, impatient, destructive, tending to resolve itself into discordant units rather than to act in harmony and in union. Gusts of passion, vociferous utterances of false doctrine sweep from their moorings thousands of minds which in ordinary days could not thus be controlled or captivated. Hence, in other parts of the Union we have seen the almost portentous rise of a political organization professing a strange and demented creed.

CONSTITUTIONAL CHANGES.

By Section 18 of Article 1 of the new Constitution, it is provided that "the right of action now existing to recover damages for injuries resulting in death shall never be abrogated, and the amount recoverable shall not be subject to any statutory limitation." As is well known, the limitation imposed heretofore by statute upon the amount of damages recoverable in such actions has been $5,000. The effect of the constitutional amendment is to supersede Section 1904 of the Code of Civil Procedure, which contained the limitation.

By Section 7 of Article 7 of the new Constitution, it is also provided that the lands of the State constituting the Forest Preserve as now fixed by law shall be forever kept as wild lands, and that they shall not be leased, sold or exchanged, or

MOGUL LOCOMOTIVE, BUILT BY THE ROGERS LOCOMOTIVE CO. FOR THE NEW YORK, SUSQUEHANNA & WESTERN RAILROAD.

be taken by any corporation, public or private. This will, in effect, hereafter prohibit the construction of railroads thereon.

ACCIDENTS.

The table of accidents for the year ending June 30, 1894, shows a slight decrease in their number as compared with the report for 1893. Seven hundred and twenty-three persons were killed and 1,821 injured, as compared with 742 killed and 2,288 injured in 1893.

The number of passengers killed from causes beyond their own control was 29; and injured, 142. Many of the injuries to passengers were but slight, such as being cut by glass, bruised, etc. Fourteen passengers were killed and 62 injured by getting on or off of trains in motion. In this volume are included the reports of investigations by the Board of all of these accidents not referred to in the report of 1893.

The number of employés killed in 1894 was 185, and the number injured 1,166, as compared with 306 killed and 1,622 injured for the year ending June 30, 1893. The equipment of freight cars with automatic air brakes and couplers undoubtedly accounts for some of this decrease, but the primary cause was the decreased number of employés, owing to decreased business.

TRESPASSERS.

Two hundred and twenty-seven trespassers on railroad tracks were killed during the year and 155 injured, compared with 197 killed and 113 injured during the year 1893. This increase may be accounted for by the increase in the number of miscellaneous floating characters or tramps whose lives are spent on freight trains or in walking between stations.

AUTOMATIC COUPLERS AND AIR-BRAKES.

Gratifying progress is being made by the various roads of the State under chapters 543 and 544 of the Laws of 1893, in regard to the equipment of freight cars with automatic couplers and air-brakes. From what the Board can ascertain as to results in other States under the act of Congress in regard to this subject, and from a perusal of the latest reports of the Interstate Commerce Commission, it is justified in expressing the belief that the equipment of this State is in advance of that of the rest of the Union. This view is decidedly confirmed by the fact that accidents to employés in the remainder of the Union seem to increase rather than to diminish, while in this State they have diminished. It is further confirmed by the contrast exhibited in this State between the increase of the deaths and injuries of trespassers and the diminution of the casualties to employés.

GUARD-RAILS AND FROGS.

Two persons have been killed and 9 injured during the past year by having feet caught in guard-rails or frogs, as compared with 11 killed and 18 injured during the year 1893. The railroad companies are observing the recommendations of this Board in regard to blocking frogs and guard-rails. This is an especially gratifying result, as the victims of this sort of accident are, without exception, employés of the companies, and it is impossible for them to protect themselves against the peril of the frog that is not blocked.

SAFETY APPLIANCES.

The Board renews its recommendations of last year in regard to the advisability of equipping passenger cars on other than single-track railroads with platform gates, and locomotive engines with a muffler for the safety-valve, and a device to protect the check-valve in ease of collision.

The tendency to increased weight of rail is noted by the action of the New York Central & Hudson River Railroad Company in laying some 70 miles of 100 lb. rails on its Hudson River Division, its purpose being to relay the whole of this division with this rail.

DOUBLE-ENDER PLANTATION LOCOMOTIVE, BUILT BY THE ROGERS LOCOMOTIVE CO.

NEW LOCOMOTIVES FROM THE ROGERS LOCOMOTIVE WORKS.

The Rogers Locomotive Company, of Paterson, N. J., have recently completed the construction of two locomotives, engravings of which we present on this and the opposite page. One was built for the New York, Susquehanna & Western Railroad, and the other for a Cuban plantation railway. The following is a list of the principal dimensions of these engines:

LEADING DIMENSIONS OF MOGUL ENGINE NO. 63, FOR NEW YORK, SUSQUEHANNA & WESTERN RAILROAD COMPANY.

Gauge	4 ft. 9 in.
Fuel	Anthracite coal.
Total wheel base of engine	22 ft. 2 in.
Driving-wheel base	14 ft. 6 in.
Weight of engine in working order	127,000 lbs.
" on drivers " " "	110,000 lbs.
" " truck " " "	17,000 lbs.
Diameter of cylinders	19 in.
Length of stroke	26 in.

Diameter of driving-wheels	54 in.
" " truck-wheels	33 in.
Type of boiler	Straight.
Diameter of boiler at front ring	66 in.
Length of firebox	131¾ in.
Width " " at grate	33 in.
Number of tubes	259
Diameter of tubes	2 in.
Length " "	11 ft.
Heating surface, firebox	197 sq. ft.
" " tubes	1,483 sq. ft.
Total	1,680 sq. ft.
Grate area	30.2 sq. ft.
Boiler pressure per sq. in	180 lbs.
Tender frame	9 in. channels.
" trucks	Fox-pressed steel.
Tank capacity, water	3,500 galls.
" " coal	8 tons.

LEADING DIMENSIONS OF DOUBLE-ENDER PLANTATION ENGINE "MARGARITA Y TERESA."

Gauge	4 ft. 8½ in.
Fuel	Bituminous coal.
Total wheel base	18 ft. 6 in.
Driving-wheel base	5 ft. 6 in.
Weight in working order	68,000 lbs.
" on drivers	38,000 lbs.
" " front truck	14,000 lbs.
" " back "	16,000 lbs.
Diameter of cylinders	13 in.
Length of stroke	22 in.
Diameter of driving-wheels	40 in.
" " truck-wheels	26 in.
Type of boiler	Belpaire.
Diameter of boiler at front ring	50 in.
Length of fire-box	40¼ in.
Width " " at grate	34¼ in.
Number of tubes	167
Diameter of tubes	1¾ in.
Length of tubes	8 in.
Heating surface, fire-box	54 sq. ft.
" " tubes	611 sq. ft.
Heating surface, total	665 sq. ft.
Grate area	9.6 sq. ft.
Boiler pressure	160 lbs.
Tank capacity, water	850 galls.
" " coal	½ ton.

THE EMPLOYMENT OF FIREMEN ON RAILROADS.

There has been a great deal written about the method of selecting the firemen who are employed on railroads. As the future engineers are generally promoted from the firemen, it is obviously important that good material should be selected for this branch of railroad service. In this connection the following form, which has been adopted on one of our principal railroads, will be interesting to many of our readers :

(FACE OF SHEET.)

APPLICATION FOR EMPLOYMENT OF FIREMEN.

All applications for employment as firemen must be made upon this form and filled up with ink in the handwriting of the applicant, giving Christian and surname in full, together with age and residence.

Name. Age. Residence.				
State names of all other railroads on which you have been employed, and in what capacities.				
State present occupation, if any ; if not, state where last employed, and give reasons for leaving last situation.				
Have you ever been employed in the service of this Company? If so, where, and in what capacity ?				
Give an example in each of the four fundamental principles of arithmetic as shown in the four right-hand columns.	Addition.	Subtraction.	Multiplication.	Long Division.
Give names and residences of at least two responsible and well-known persons who will vouch for your good character—preferably your former employers.				

In case I am employed, I agree to abide by and be governed by the rules of the Company, to abstain from the use of intoxicating liquors, and pay my obligations without annoyance to the Company ; to keep the engine or engines to which I may be assigned clean and neat ; to be careful in the use of fuel, and protect the Company's property as far as lies in my power.

(Signature of applicant)

....

Date..

(Over)

(BACK OF SHEET.)

Application of

....

For employment as

....

....189–

Approved

....Supt.

Applicant Employed

....189–

....

Master Mechanic.

....

Station.

RULES GOVERNING THE EMPLOYMENT OF LOCOMOTIVE FIREMEN.

In the selection of men for the position of locomotive firemen, the following rules will be observed :

1. All applications must be filled out with ink in the handwriting of the applicant, who will give his Christian and surname in full, age and residence.
2. Where they possess the necessary qualifications, preference will be given to employés such as helpers, wipers, hostlers, machinists, brakemen and trackmen, whose employment has made them somewhat familiar with an engine.
3. All applicants must be able to read and to write legibly, and understand mathematics as far as addition, subtraction, multiplication and division, and to be not less than twenty-one nor more than twenty-eight years of age.
4. All applicants will be required to furnish recommendations from two (2) responsible and well-known persons as to honesty, sobriety and character in general.
5. All applicants will be required to learn the duties of the position without compensation before they are assigned to duty.
6. All applicants will be required to pass a satisfactory physical examination as to their ability to perform the duties of a fireman ; also as to hearing and sight and ability to distinguish colors, as required by the rules of the company.
7. Firemen will be required to abstain from the use of all intoxicating liquors, and to pay their obligations without annoyance to the company.

NOTE.—All applications for employment as firemen must be made to the master mechanics of the respective divisions, who will forward same to their respective superintendents for approval, and return for file in the office of the master mechanic.

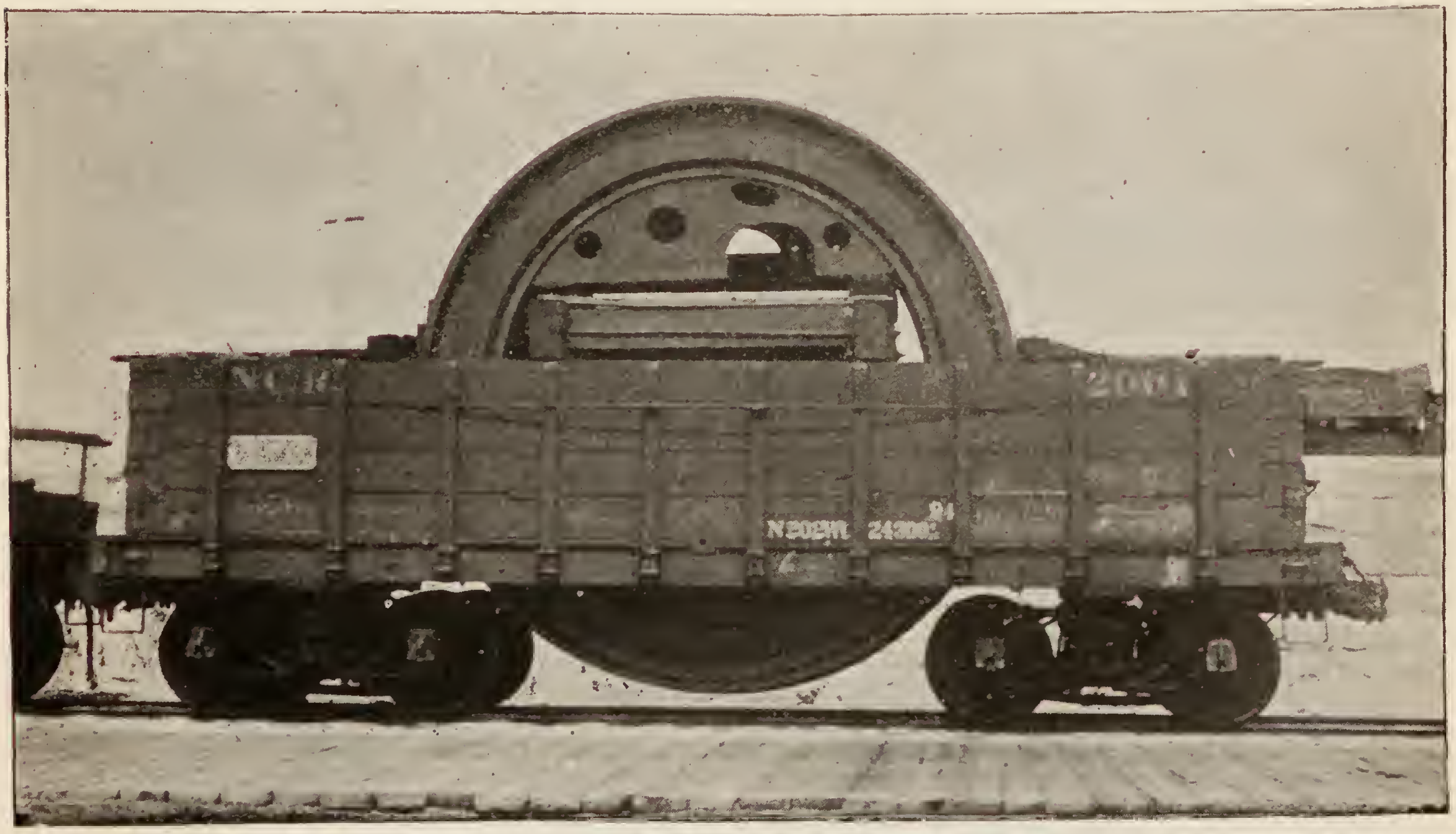
A SHIPMENT OF MORTAR CARRIAGES.

The construction of heavy ordnance and the necessity of shipping it from the points of manufacture and testing to its final position in the fortifications for which it is intended has necessitated some radical changes in the cars that are used for this purpose. When the great Krupp gun was sent to the Columbian Exhibition the Pennsylvania Railroad built a special car for its transportation, which was illustrated and described in our issue for May, 1893. In the illustrations on page 85 we show the method that was adopted for the shipment of the heavy mortar carriages from Sandy Hook to San Francisco. There were 12 of the carriages to be shipped, each weighing about 33 gross tons. They are intended for the 12-in. breech-loading mortars to be planted in the fortifications of San Francisco Harbor. The largest pieces in the carriages are the upper and lower roller paths on which the carriage proper rests. These paths are 14 ft. in diameter and weigh about 12 tons each. As this diameter is too great to permit that they should be carried horizontally, it was, therefore, necessary to load them upon the car in a vertical position. For this purpose a gondola car was especially prepared by cutting away a portion of the floor in the shape of two square holes of the suitable width and of a length a little less than the diameter of the paths. A heavy timber framework was then built up on the floor with a square opening through it to correspond with that in the floor. The different portions of this frame were fastened together by heavy bolts and tie rods. It was so arranged that each car would carry two paths for the carriage.

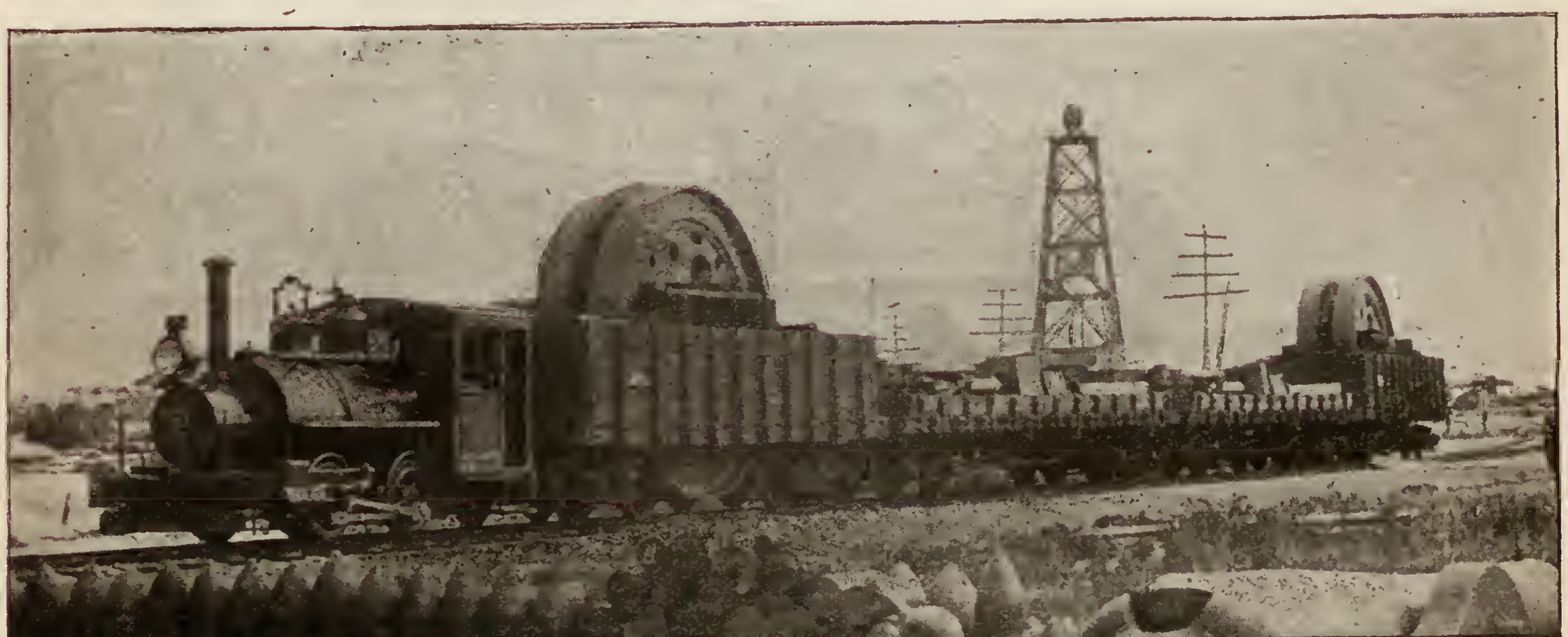
A part would be hoisted high enough to clear the car, which would then be run under it and the part lowered into position and then secured by wedges to the framework. The lowest point of the roller path is 7 in. above the top of the rail, and with the height thus created of 14 ft. 7 in. above the rail the

car can safely pass through any bridge or tunnel between New York and San Francisco.

The side frames and other parts of the carriage are loaded upon other cars. The two photographs illustrate both the single car with its load and the train consisting of four cars containing two carriages. Twelve cars with six carriages were shipped in September, and two in each one of the last three weeks in December.



GONDOLA CAR LOADED WITH MORTAR CARRIAGE PATHS.



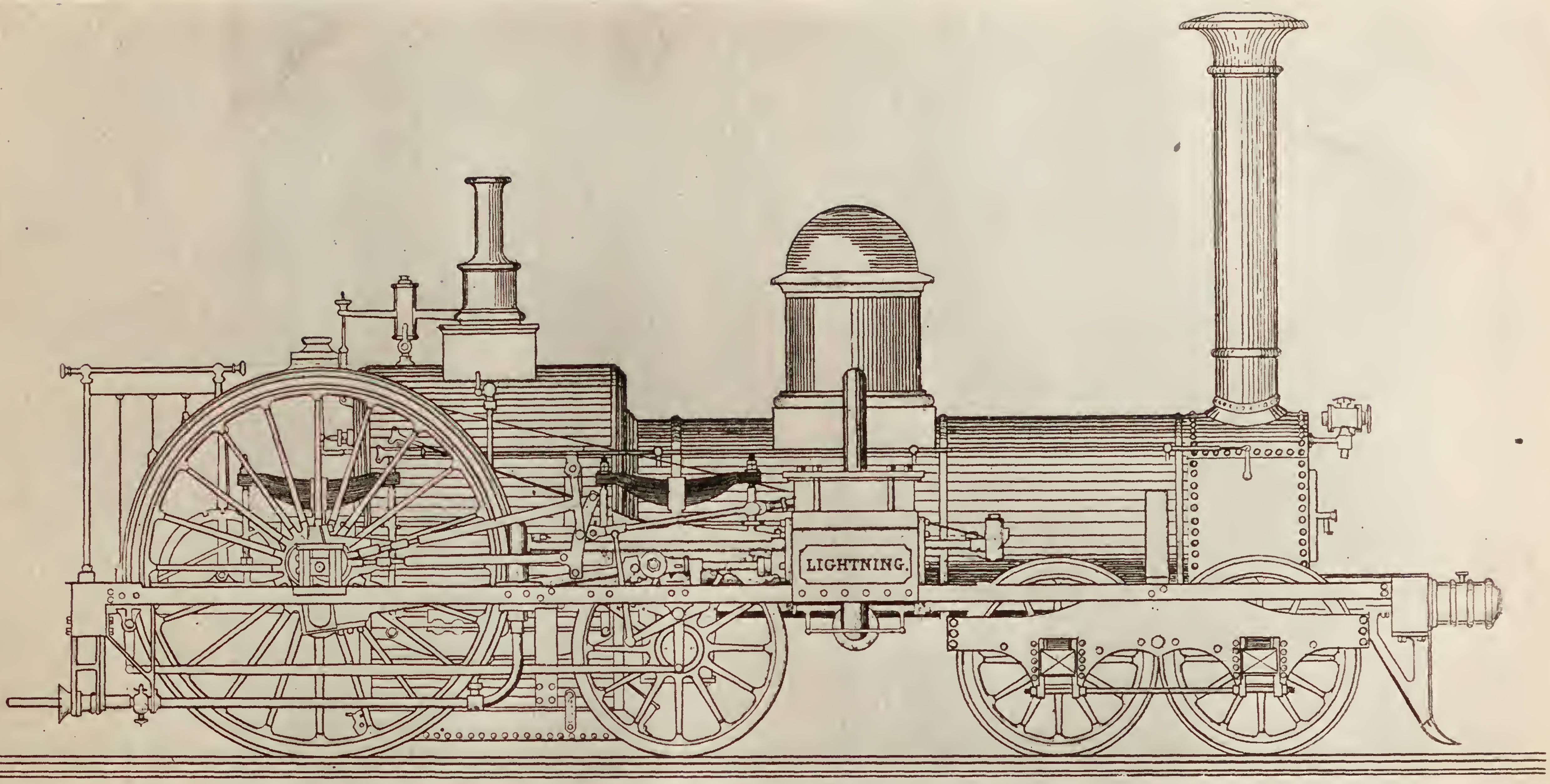
TRAIN OF FOUR CARS LOADED WITH MORTAR CARRIAGES.

RAILROAD NOTES.

Compressed air and its applications to railroad work received quite an exhaustive discussion at the hands of the Master Car-Builders' committee chosen to report upon that form of stored energy at the recent Saratoga convention. Evidently the committee did its work well; but it could not be expected that *every* application of compressed air could be tabulated in their report, or even recognized or discovered by them.

A recent application of compressed air is to a track gouger built by the Delaware, Lackawanna & Western Railroad, and now in the division shops at Syracuse, N. Y. In the usual form of "gouger" or "flanger," as called in different localities, the scraper or plough is raised by long levers operated by several men to each lever. That these men may act at the right time and raise the plough to clear frogs, switches and crossings, it was necessary to provide windows or look-out holes in the car, from which a very close watch could be kept for the obstructions mentioned above.

In the new flanger the lever and man-power are dispensed with entirely, and a single air-brake cylinder and 60 lbs. pressure of compressed air made to do the work of several men. The ploughs are hung underneath the car in the usual locality; but instead of being suspended from levers placed on the car floor, these ploughs are hung to a double rocker arm placed underneath the car floor framing, to which the air cylinder has its piston directly attached.



Lightning, 1849.

BUILT BY EDWARD S. NORRIS, AT THE NORRIS LOCOMOTIVE WORKS, SCHENECTADY, N. Y.

The control of the compressed-air cylinder lies in a three-way cock, wherewith air is admitted to either end of the cylinder and exhausted therefrom at will of the operator, who sits upon a kind of deck or look-out house built on top of the car, much in the same manner that some freight cabooses are constructed. By means of compressed air and the three-way cock the entire control of the flanger is put within the limit of one man's capabilities. All the lever hands are dispensed with, and the flanger man sits up there in his little look-out house running the ploughs closer to, and putting them down again much quicker after passing an obstruction than was ever done by a hand-operated machine. Only a man or two need be sent out with the operator on a flanger, and they will be required only in case of accident.

Air is taken from the train pipe; but a special reservoir tank is provided between the train pipe and the flanger cylinder. The special tank takes air through a very small opening to the train pipe, so small, in fact, that the air pressure in train pipe is not diminished enough to set the brakes, even if the small opening mentioned be left open to the atmosphere. Train-pipe pressure is thus maintained in the special tank without affecting the air brakes.

The ploughs or scrapers (one for each rail) are hinged to the rocker arms and kept up to their work by chains extending forward and backward so as to form braces or ties to hold the scrapers in place. Thus the car can run either end forward and do the flanging equally well. In each chain a cast-iron link is placed. This link is shaped like the letter C, and, like it, has an opening in one side, so it can be hooked into the rest of the chain. The opening, or slot, is made diagonally instead of square across, so that the chain cannot unhook itself whenever it gets slack. The cast-iron links are cheap, and are easily replaced when broken. When the operator neglects to raise the ploughs during the passing of a switch or a crossing, the cast-iron links break before the chain can give way, thus preventing any danger of breaking anything else.

Some master mechanics have a better idea of or confidence in cast iron than is possessed by a majority of railroad engineers. Colonel Brown, Master Mechanic of the Delaware, Lackawanna & Western Railroad, at Scranton, Pa., evidently is one of the "cast-iron men," as he uses that material for guides on a number of the heaviest locomotives on his division. The cross-head is enlarged to take the big guide-bar made necessary by the use of cast iron. No broken guide-bars have been reported yet, and the cost of manufacturing is much less than the expense of forging and planing up steel or wrought-iron rods.

Spade handles are also forged differently in this shop than on most roads. Instead of being made solid with the rod and cut out on a slotter, the spade handles made in the Scranton shops are in two parts. Making the rod is about like finishing up a "stub end;" then the spade handle, formed in another piece, is bolted.

The different engineering treatment required to produce economy of the same machines is pretty well illustrated by a comparison of the culm-burning locomotives of the Delaware, Lackawanna & Western and the locomotives of the Manhattan Elevated Road, in New York; the former, especially in the mountain division, have to be fitted with enormous grate area, in order to do the work required of them. The latter, contrary to all precedent in railway locomotive practice, have very small grate area; and while the former grate areas have been increased to the limit allowed by the standard gauge of track, the grate area of the locomotives for the elevated railroad has been cut down to about 18 ft. with good results.

The difference between 18 sq. ft. and 80 sq. ft. for grate area is considerable, but it is fully met by the difference in conditions under which the locomotives are to be used, the constant stopping and short runs of the locomotives of the elevated road showing better economy with ample boiler room and heating surface and contracted grate area, while the long, hard pull of the big machines require the greatest amount of "lung power" (*i.e.*, grate area) that can be given them.

The municipal authority who orders engineers and firemen to be taken from their cabs under arrest for burning soft coal gives a fine exhibition of that human characteristic which is tolerated by society when the opposing armies of two generals commit wholesale murder. The cases are parallel, especially in the one exemplified by the arrest of engineers and firemen on the Long Island Railroad for violating the smoke ordinance. If one general should plan to kill his opponent, and thus end the struggle by the death of a single man, the successful plotter would be denounced as a murderer, as a man of anarchistic tendencies; but let his hirelings commit wholesale murder with those of the opposing commander, and it is only war.

In the case of the City *v.* The Long Island Railroad Company, had the authorities promptly arrested the directors of the company they would have been condemned as anarchists; but as they only imprison a few *servants* of the company, who are obeying orders in burning soft coal, then the dignity of the city is upheld, and the railroad continues to transgress.

I. F. H.

AN EARLY NORRIS EXPRESS LOCOMOTIVE.

The engraving on the opposite page is from an old print of a locomotive built by Edward S. Norris, at the Norris Locomotive Works, when these were located at Schenectady, N. Y. The Norrises, who afterward moved their business of locomotive building to Philadelphia, began in Schenectady, and their old shop was the beginning of the present Schenectady Locomotive Works.

The *Lightning* had 7-ft. driving-wheels and 16 × 22 in. cylinders. The truck-wheels were 42 in., the trailing-wheels 48 in. and the boiler 42 in. diameter. The latter had 116 2-in. tubes, which were 10 ft. 3 in. long. The fire-box was 54 × 36 in. The weight of the engine was 20 gross tons. The engine was built and was used on the Utica & Schenectady Railroad.

Mr. William Buchanan, who remembers this engine very well, says that the boiler was too small to make steam, the cylinders were not large enough for the driving-wheels, and the wheels had not weight enough for adhesion, and that consequently the engine was not successful. It will readily be seen that without sufficient steam generating capacity, tractive force, or adhesion that a locomotive must be a very inefficient machine. It will be seen that even at this early date it had a stationary link-motion for its valve gear. A comparison with an illustration of one of Crampton's locomotives, published in *Clark's Railway Machinery*, will show that they closely resemble each other, and probably the Norris design was suggested by Crampton's engines. The system of locating the driving-axle behind the fire-box, with some minor novelties, formed the subject of a patent granted to Crampton in 1843. The first of his engines was built in 1846, and had six wheels. It was tested on the London & Northwestern Railway. Another, the *Liverpool*, with eight wheels, was built for that road in 1849. The side view of this engine, which is given in *Clark's Railway Machinery*, resembles very closely that of the *Lightning*. All the wheels of the *Liverpool* were attached to rigid frames, whereas it will be seen that the four front wheels of the Norris engine formed a truck or Anglice "bogie." The *Liverpool* had 8-ft. wheels and 18 × 24 in. cylinders, and weighed 35 tons, 12 of which were carried by the driving-wheels.

In commenting on this engine, Clark says: "The unsoundness of the policy of gettting up heavy engines, merely to show what can be done, is apparent. . . . This splendid monster worked the express train between London and Wolverton for some time, and on one occasion conveyed a train of 40 carriages within time—more than work for three ordinary engines; it was, however, laid aside on account of its excessive weight"—all of which sounds rather queerly in these days, when engines of more than double this weight are not uncommon.

BORK'S BRICK-LINED LOCOMOTIVE FIRE-BOX.

In The American Engineer for September, 1893, there was published a translation of an article which appeared in *Glaser's Annalen für Gewerbe und Bauwesen*, describing a fire-box for locomotives designed by Mr. Bork, Locomotive Superintendent.

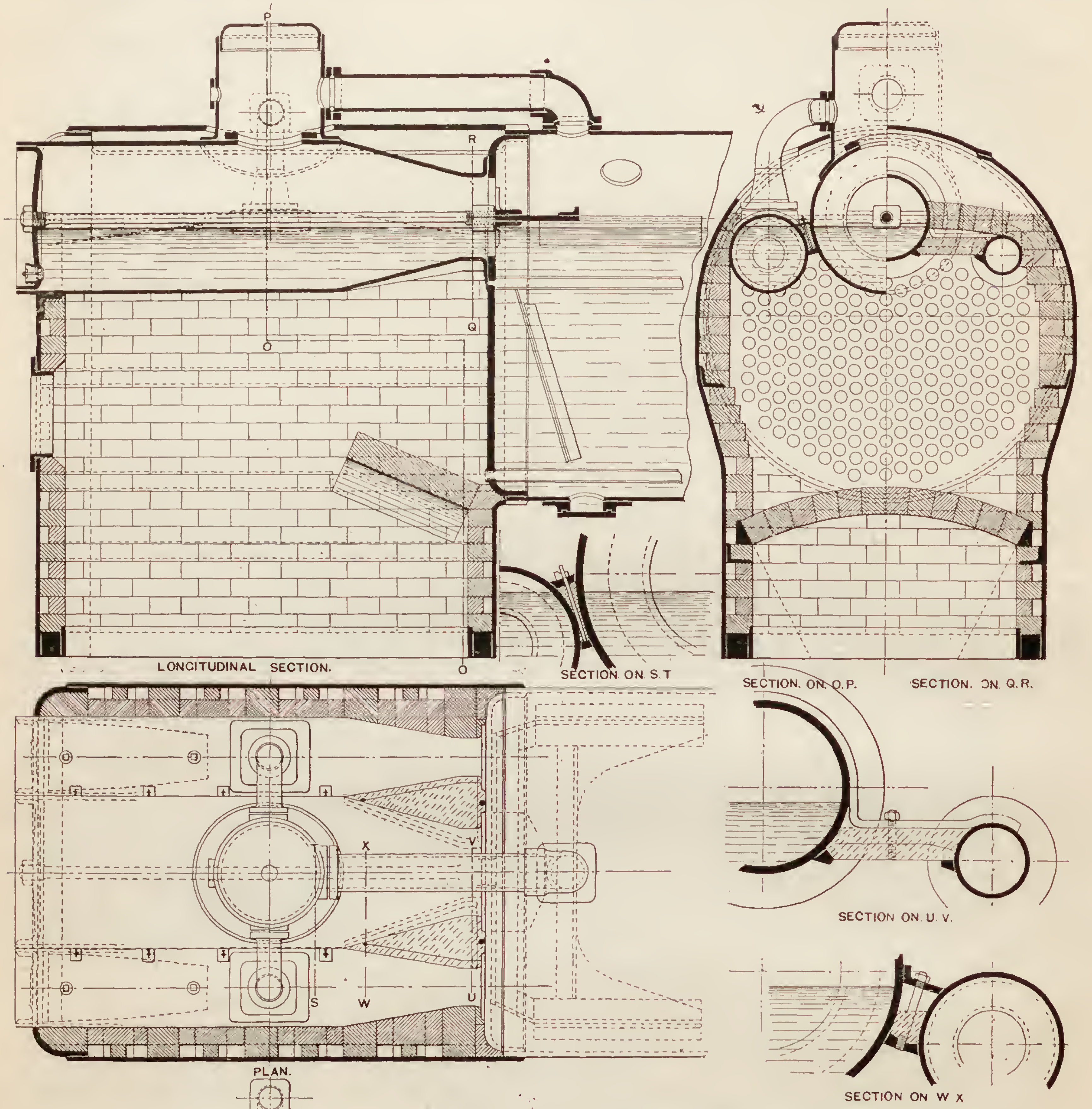
In that paper the author said:

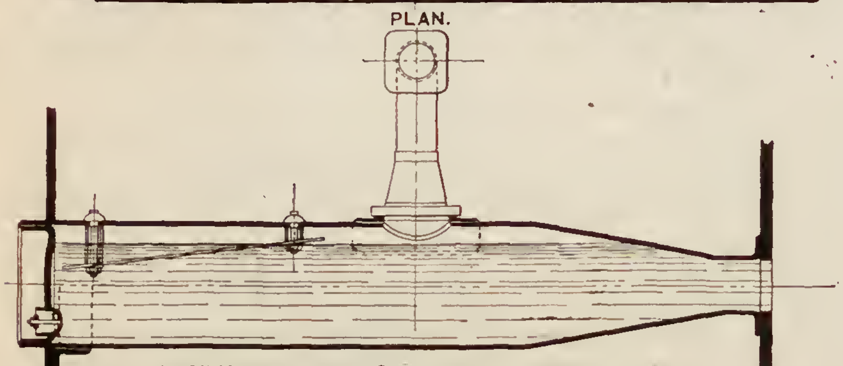
"It is a remarkable fact that the locomotive boilers built for the first railroads have been retained unchanged as the type for later constructions, in spite of the great disadvantages resulting from the arrangement of the fire-box, and which have been recognized from the beginning. The large number of stay-bolts and braces which are required, the universal use of flat surfaces for the sides of the fire-box, against which the steam pressure acts, the great cost of construction, its favorable arrangement for the deposition of scale, and the difficulties which it presents for the removal of the same, should all militate against it. Then the thicker the layer of scale that is formed, the greater is the loss of evaporative efficiency of the boiler. . . . .

"The renewal and maintenance of the fire-box, besides adding a very considerable amount to the repair account, also serve to keep the locomotive for a considerable length of time out of service. Besides this, even with the most scrupulous care, the fire-box must always be considered the most danger-

ous part of the locomotive, and it is well known that the great majority of locomotive boiler explosions take place either in the fire-box itself, or the outer shell of the same."

Besides being the most dangerous part of a locomotive, it may be added that the fire-box is the most expensive part in its first cost of construction, and also in its maintenance. It is a source of constant anxiety to those who run locomotives, and to those who have the responsibility of their care. This is due to the fact that the inside plates which are exposed to the fire, the stay-bolts and braces, and, in fact, the whole structure are subjected to great strains, which are very imperfectly understood, are exposed to constant deterioration, and are always liable to fail, and—as Mr. Bork has pointed out—more explosions occur in the fire-boxes than in any other part of locomotive boilers. If we could get rid of the plates exposed to the fire, to all stay-bolts, braces and crown-bars, and have no parts subjected to the excessive and uncertain strains which fire-boxes must resist, and if this could be done at a reduced first cost, less expense for repairs and maintenance,





BORK'S BRICK-LINED LOCOMOTIVE FIRE-BOX.

and no reduction, but rather an increase of efficiency, it must be admitted that it would be a very great advance.

Mr. Bork claimed in the paper from which we have quoted that he had achieved all these results. In that paper he said : "For building an entirely new boiler with the brick fire-box, having a capacity sufficient for the standard freight engine, the expense would be about 6,000 marks ($1,500), while the cost of a boiler of similar efficiency of ordinary construction (with copper fire-box) would be 11,000 marks ($2,750)." He said further : "The efficiency of the locomotive, after the new design of boiler was placed upon it, was at least equal to that which it had originally. . . . The coal consumption was generally 10 to 25 per cent. less, as shown by the premium awards." Continuing, he said : "Aside from the improved steaming qualities, whereby a lower consumption of coal pro-

duced the same efficiency, there are two facts which seem to particularly warrant the introduction of this new type of boiler, to wit :

"1. A very greatly reduced outlay in first cost, and

"2. Possibility of an important increase of steam pressure, and therefore an increase of efficiency, without a corresponding increase in the weight of the locomotive."

The author then went on to make a careful comparison between the expense of construction and maintenance of the copper fire-box and the brick-lined fire-box of his new construction. As copper fire-boxes are not used in America now, these figures do not show what the relative expense would be between the brick-lined box and the steel box used in this country ; but his conclusions relative to the copper fire-box are that there is a saving of maintenance of about 29 per cent.

Notwithstanding these statements, which have not been refuted, and which there does not seem to be any good reason to doubt, the claims of Mr. Bork have been received with the greatest apathy and apparent scepticism by master mechanics and locomotive superintendents, both in this country and in Europe. There somehow seems to be an incapacity on their part to adjust their minds so as to be able to recognize the significance of what Mr. Bork and others have shown—viz., that the present costly and dangerous form of locomotive fire-box is not essential to its successful working, and probably is more expensive, less efficient, and not so economical as a fire-box may be if the water spaces around the fire are omitted, and a simple shell lined with fire-brick is substituted for what our colored brethren would call our old "misery."

In view of all these facts and hypotheses, we take pleasure in giving our readers engravings of the latest form of fire-box which Mr. Bork has designed. Naturally experience has suggested some improvements and changes. A comparison of the engravings given herewith and those published in our issue of September, 1893, will show that the chief change which Mr. Bork has made is in adding two additional crown cylinders over the furnace instead of having only one supplemented with a brick arch, as in his first design.

We are indebted to Mr. Charles Brown, of Basel, for the drawing, and also for some observations on Mr. Bork's fire-box and some extracts from a letter which he (Brown) has received from Mr. Bork. Mr. Brown says :

"Bork's memoir (published in The American Engineer, September, 1893) is very interesting, and is worth reading very attentively, for if what he says is true there is a future for this invention, notwithstanding that the routine people cry it down.

"The supporting cylinders employed by Bork for supporting the fire-box roof is, I think, an improvement, as it is here that these boxes first fail.

"Mr. Bork writes to me, as under, in reply to several questions I put concerning the durability, up-keep, etc., of his fire-boxes. These questions you will also find anticipated in his memoir :

"'We have now before us the experience of one and one-half years with the new locomotive boiler, and I can confidently assert that my expectations have been fulfilled ; and although the heating surface is somewhat less than before the boiler was converted from a copper to a brick fire-box, that the engine performed its usual service with *less* fuel than with the copper box.

"'Leaky tubes have never been observed during the one and one-half years' service ; repairs have consisted only in the renewal of the fire-bricks (six times) immediately above the fire. This work is done without having to go into the repairing shops ; it takes about four hours, and is carried out in the engine house (Heitzhaus) during the regular wash-out stoppages.'"

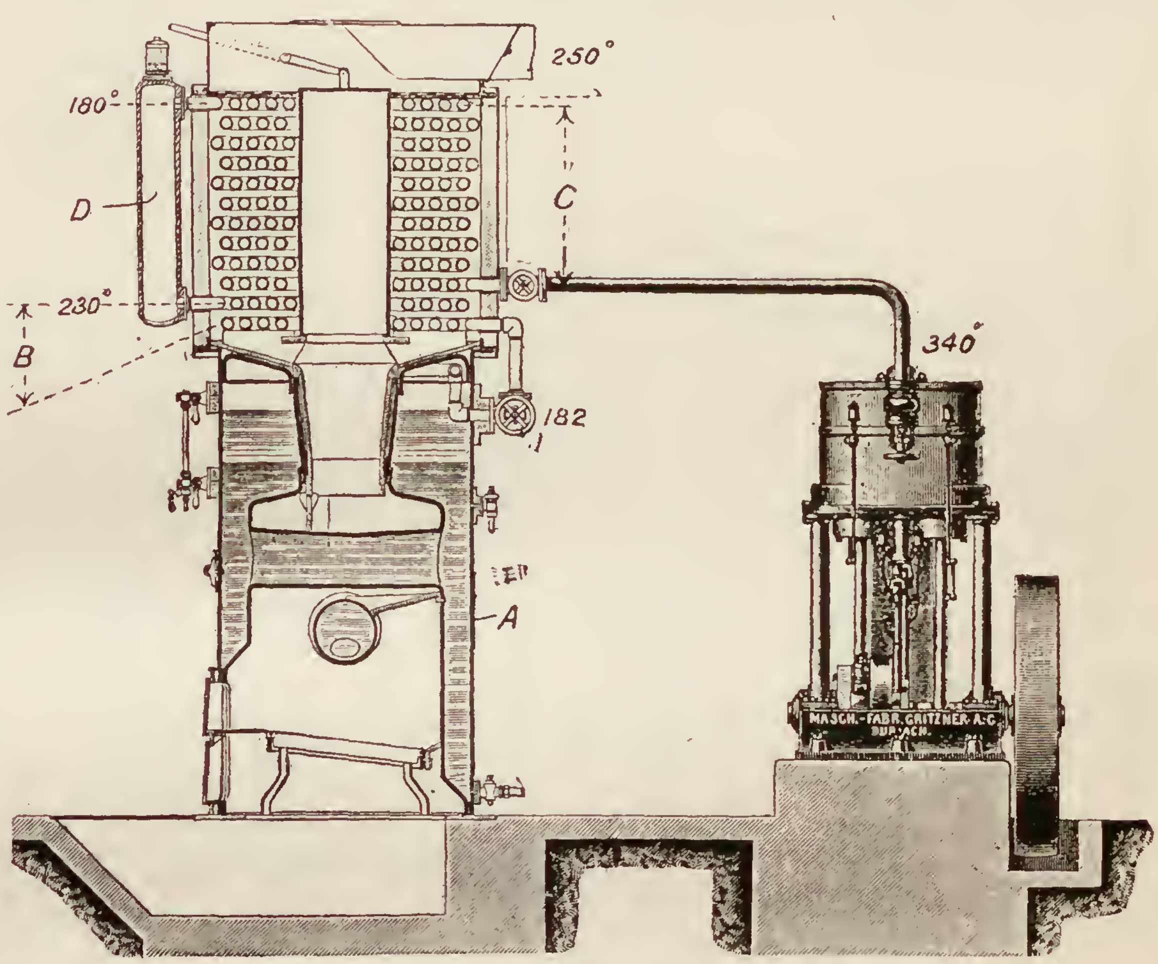
Mr. Brown adds : "One very important point has been brought to light by Bork's experiments : it is that the brick box requires less air for combustion than the water-space box ! This has been proved by analysis of the products of combustion ; the old fire-box requires per kilogram of combustible 26.6 kilograms of air, or together 26.6 + 1 = 27.6 kilograms. The brick box requiring only 19.9 kilograms, or together 19.9 + 1 = 20.9 kilograms. This being the case, the tubes have less work to do, the volume of gas being less, or, better said, a less surface suffices to extract the heat, the temperature being higher. This explains what was observed, that the temperature of the smoke-box was not higher than in the case of the water fire-box."

Whether the "routine" people will ultimately be able to grasp the significance of the facts which Mr. Bork has elucidated is still uncertain. Probably some mental trepanning will be required in order to give room for the idea in the minds of that class of persons who resist all innovations.

SCHMIDT'S SUPERHEATED-STEAM BOILER AND ENGINE.

The engraving herewith represents a section of a boiler and a view of an engine which is the invention of Mr. William Schmidt. From a descriptive circular issued by the Gritzner Machine Works, at Durlach, Switzerland, we have made the following translation :

"Modern steam-engine practice has reached such a high degree of perfection at the present time, that it is difficult to conceive how any very great improvement can be made if we work along the beaten path. The great evil of the steam-



SCHMIDT'S SUPERHEATED-STEAM BOILER AND ENGINE.

engine of to-day consists in the fact that the slightest lowering of the temperature of the so-called saturated steam produces an immediate lowering of the pressure. Hence it happens that when fresh steam is admitted from the boiler into the engine some of it is condensed by the lower temperature of the cylinder walls, and it is therefore lost as far as the performance of effective work is concerned. The loss resulting from this is the greatest in the common condensing engine, and may amount to as much as 60 per cent. of the steam used. This loss can be diminished by the use of the steam jacket or by expanding through several cylinders, although this will be very far from doing away with it altogether. It has been known for a long time that superheated steam does not share in this disadvantage, in so far as the superheating reaches a definite point. Hence, several types of apparatus designed to accomplish these results have been designed. The reason why success has not attended these efforts lies in the fact that either the apparatus was not properly built, or that the superheating was not carried sufficiently far.

"The invention of Schmidt's superheating boiler therefore marks an interesting departure, and gives the power to obtain

LOCOMOTIVE RETURNS FOR THE MONTH OF OCTOBER, 1894.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage. Passenger Trains.	Locomotive Mileage. Freight Trains.	Locomotive Mileage. Service and Switching.	Locomotive Mileage. Total	Locomotive Mileage. Average per Engine.	Av. Train. Passenger Cars.	Av. Train. Freight Cars.	Coal Burned per Mile. Passenger Train Mile.	Coal Burned per Mile. Freight Train Mile.	Coal Burned per Mile. Service and Switching Mile.	Coal Burned per Mile. Train Mile, all Service.	Coal Burned per Mile. Passenger Car Mile.	Coal Burned per Mile. Freight Car Mile.	Cost per Locomotive Mile. Repairs.	Cost per Locomotive Mile. Fuel.	Cost per Locomotive Mile. Oil, Tallow and Waste.	Cost per Locomotive Mile. Other Accounts.	Cost per Locomotive Mile. Engineers and Firemen.	Cost per Locomotive Mile. Wiping, etc.	Cost per Locomotive Mile. Total.	Cost per Car Mile. Passenger.	Cost per Car Mile. Freight.	Cost of Coal per Ton.
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Atchison, Topeka & Santa Fé	864	787	....	....	306,870	2,058,213	2,615	....	....	....	....	....	82.95	....	..	3.59	7.25	0.24	0 16	6.69	1.32	19.25	...	...	1.68
Canadian Pacific	610	....	490,142	962,656	311,255	1,764,053	....	....	....	....	....	...	69.00	....	....	3.52	10.18	0.22	....	5.76	1.12	20.80	....	1.64	2.96
Chic., Burlington & Quincy	541	....	....	....	....	1,469.318	...	5.15	19.86	...	...	....	84.56	....	....	3.34	5.21	0.18	0.19	6.76	....	15.68	....	....	1.26
Chic., Milwaukee & St. Paul	852	....	....	....	....	2,408,853	....	....	..	....	....	....	74.47	....	..	3.59	7.15	0.25	...	6.84	..	17.83	....	....	2.10
Chic., Rock Island & Pacific	564	....	484,509	942,678	287,723	1,714,910	....	5.50	18.10	54.86	75.87	42.28	64.74	10.02	4.58	3.87	6.33	0.21	1.57	6.09	0.44	18.51	....	....	2.04
Chicago & Northwestern	1010	....	811,307	1,592,644	720,494	3,124,445	....	....	...	....	...	....	86.39	..	....	3.16	7.73	0.27	....	6.27	0.76	18.19	....	....	1.77
Cincinnati Southern	....	....	....	....	....	....	....	....	....	....	....	....	....	....	...	....	....	...	...	....	....	....	...	....	....
Cumberland & Penn.*	..	23	5,385	39,595	....	44,980	...	....	...	....	....	....	84.03	....	...	5.62	4.55	0.34	....	..	1.58	12.09	...	....	
Delaware, Lackawanna & W. Main L	213	195	73,310	605,937	....	679,247	3,483	....	..	...	...	....	78 93	....	....	3.13	5.80	0.40	....	5.67	....	15.00	....	....	1.47
Morris & Essex Division	...	162	185,077	229,043	16.226	430,346	2,656	....	....	...	....	....	65.61	....	....	3.56	10.25	0.32	...	6.94	....	21.07	....	....	3.10
Flint & Père Marquette	....	....	....	....	....	....	....	....	....	...	....	....	....	....	....	....	....	....	....	....	...	....	....	....	....
Hannibal & St. Joseph	...	69	66,048	137,809	38,966	242,821	3,624	5.04	17.04	....	....	....	81.66	14.57	6.16	3.12	5.16	0.11	0.30	6.63	....	15.32	....	....	1.33
Kansas City, Ft. S. & Memphis	138	....	96,571	181,636	92,001	370,208	3,010	....	....	....	....	....	64 22	....	....	3.29	4.71	0.30	0.38	7.34	....	16.02	....	....	1.42
Kan. City, Mem. & Birm	42	36	35,211	53,775	12,636	101,622	2,823	....	....		....	...	59.48	....	....	4.04	2.85	0.32	0.26	6.66	....	14.13	....	...	0.96
Kan. City, St. Jo. & Council Bluffs	....	....	....	....	....	....	...	...	....	....	....	....	....	....	....	....	....	....	....	....	....	....	...	...	....
Lake Shore & Mich. Southern	591	....	374,540	800,795	458,168	1,633,503	3,047	....	....	62.09	89.36	47.65	69.30	....	....	2.85	5.19	0.10	0.05	6.97	0.12	15.28	....	....	1.49
Louisville & Nashville	..	...	....	....	....	....	..	....	....	....	..	....	....	....	....	..	....	....	...	....	....	....	...	....	....
Manhattan Elevated	....	286	751,834	....	67,811	819,645	2,865	....	....	....	....	....	38.20	....	....	2.40	7.70	0.20	0.50	9.30	....	20.10	....	....	4.00
Mexican Central	148	133	....	....	....	451,556	....	.	...	....	....	....	61.89	....	....	4.00	11.39	0.40	0.12	4.93	....	20.84	....	....	3.64
Minn., St. Paul & Sault Ste. Marie	104	82	89,707	137,420	29,608	256,435	3,127	4.64	21.48	....	....	....	69.15	....	4.59	3.77	8.40	0.25	....	6.45	....	18.87	3.61	1.04	2.39
Missouri Pacific	...	....	....	....	...	....	....	....	....	....	....	....	....	...	....	....	....	....	....	....	....	....	....	....	....
Mobile & Ohio	105	84	76,933	150,384	55,932	283,249	3,372	....	23.50	....	....	....	65.01	...	....	2.75	4.16	0.20	0.58	5.78	0.95	14.42	....	....	1.28
N. O. and Northeastern	....	....	....	....	....	....	....	...	....	...	....	....	....	....	....	...	....	....	....	..	.	....	....	....	..
N. Y., Lake Erie & Western	....	265	442,511	795,032	251,406	1,488,949	3,000	4.50	24.80	84.50	135.10	87.05	...	18.90	5.50	4.32	7.36	0.33	1.78	7.39	1.23	22.41	....	1.54	1.34
N. Y., N. H. & H., Old Colony Div	....	....	....	....	....	....	...	....	....	...	....	....	...	....	....	....	...	....	....	....	....	...	....	....	...
N. Y., Pennsylvania & Ohio	....	287	129,494	408,844	157,351	695,689	3,379	5.40	19.60	69.10	124.10	84.60	....	12.70	6.30	3.35	5.58	0.29	1.81	7.09	1.01	19.13	....	1.53	1.07
Norfolk & Western, Gen. East. Div.†	....	....	99,389	322,137	57,853	479,379	2,771	5.40	21.00	47.42	111.61	....	....	8.86	6.41	6 04	3.60	0.27	....	....	....	9 91	....	....	...
General Western Division†	....	....	106,891	371,559	64,724	543,174	2,760	5.29	17.11	74.00	135.00	103.00	118.00	13.99	7.90	6.74	4.09	0.24	....	....	....	11.07	....	....	....
Ohio and Mississippi	....	...	....	....	....	....	....	....	....	....	....	....	....	....	...	....	....	....	....	...	....	....	....	....	....
Philadelphia & Reading	....	..	454,180	828,114	491,033	1,773,327	....	....	....	....	....	....	79.30	...	....	4.95	4.46	0.37	....	5.83	0.40	16.01	....	...	.. .
Southern Pacific, Pacific System	721	652	625,498	1,149,844	245,732	2,021,074	3,100	5.33	14.77	....	....	....	70.82	....	...	5.28	17.18	0.18	2.06	7.40	1.04	33.14	....	..	4.86
Union Pacific	739	427	427,714	991,269	397,924	1,816,907	2,830	6.47	20.43	....	....	....	109.30	14.92	6.92	5.86	9.52	0.40	....	7.68	0.93	24.39	1.46	3.83	1.73
Wabash	416	338	431,266	636,023	225.458	1,292,747	3,824	4.76	16.89	....	....	....	88.85	15.05	6.54	3.61	5.28	0.28	....	5.63	0.82	15.62	3.07	1.02	1.19
Wisconsin Central	149	116	142,003	216,646	81,765	440,414	....	...	....	....	....	....	82.27	....	....	2.64	6.76	0.15	....	6.67	0.75	16.97	....	....	1.64

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars. Empty cars which are reckoned as one loaded car are not given upon all of the official reports, from which the above table is compiled. The Union and Southern Pacific, and New York, New Haven & Hartford rate two empties as one loaded; the Kansas City, St. Joseph & Council Bluffs, and Hannibal & St. Joseph Railroads rate three empties as two loaded; and the Missouri Pacific and the Wabash Railroads rate five empties as three loaded, so the average may be taken as practically two empties to one loaded.

* Switching engines allowed 6 miles per hour; wood, construction and gravel trains, 10 miles per hour.

† Wages of engineers and firemen not included in cost.

results that have heretofore been unknown in practical experience. As an example thereof we give a few figures which have been obtained in tests of Schmidt's apparatus :

The Tests were Made by	Type of Engine.	Brake H.P.	Duration of Test.	Steam Consumption.	Coal Consumption.
				Per Brake H.P. per Hour.	
Berlin Steam Boiler Inspection Company......	Non-condensing single cylinder compound	3.5	8 hours.	11.7 Kg.	1 90 Kg.
C. Schneider, Chief Engineer........,.........		39.0	8 "	7.7 "	0 90 "
G. de Grahl, Engineer.... .		20.0	8 "	8.8 "	1.20 "
Professor R. Schöttler, Brunswick, Geh. Rath. Prof. Lewicki, Dresden..		69.0	8 '	7 9 "	1.10 "
Professor M. Schroter, Munich....	Condensing engine.	62.0	8 "	5.5 "	0.69 "

"The principal feature of the Schmidt invention lies in the simple arrangement of the superheaters. As shown in the figure, it consists of a steam generator formed of an ordinary upright boiler *A*, upon which a superheater consisting of spiral wrought-iron tubes is placed. The liberated steam enters the lowest coil in a damp condition, and is here dried by the hot gases. From the next to the lowest coil it passes into an upright chamber, *D*, in which it is comparatively quiet, and where an opportunity is given for the conversion of any particles of water that may have been entrained into steam. From here the steam goes into the upper coil and then passes downward through the principal superheater, from the top to the bottom, while the hot gases move in the opposite direction. From the lowest point of the superheater the steam flows out and into the engine. These then are the principal arrangements of Schmidt's superheating boilers, from which such fine results have been obtained. The prominent feature of the construction consists in the fact that the temperature of the walls of the tubes composing the superheater at no time reaches such a point that there is any danger of burning the metal. Therefore the durability of this important adjunct of the apparatus is well insured. Another advantage of Schmidt's boiler is found in that, while the ordinary production of steam from a boiler of such a size would be small, it is so increased in volume by the action of the superheater, that at 350° C. this increase may amount to as much as 35 per cent. above saturated steam of the same weight.

"The steam-engine differs very slightly from those heretofore in use ; it is exceedingly easy to manufacture, and this is especially so in that the cylinder has no stuffing-box and is open upon one end, so that the steam acts upon the pistons alternately. In other respects this steam-engine is built upon the lines of the modern engine, and has, above all, a very sensitive independent governor. In small engines up to 20 H.P. there is a hollow cross-head guide that is really superfluous, and the piston-rods are fastened directly to the inner half of the pistons ; on the larger engines the hollow guide is still retained, but it may be either bored out or flat.

"The lubrication of the cylinder is accomplished by means of a mechanical lubricator in which only valvoline oil should be used, such as is made by Breymann & Hubener, in Hamburg. The other parts are lubricated by the fixed drip oilers, in which any good oil may be used.

"The fly-wheel is of the regulation type and serves to keep the engine steady, and it can also be used as a belt-pulley.

"A feed-pump is attached to the machine, which furnishes the boiler with the water that may be required, passing it through a heater before it enters the boiler, wherein it is heated by the exhaust from the engine. It enters the boiler at a temperature of about 90° C."

A correspondent in whose mechanical judgment we have great confidence, and to whom we are indebted for the circular referred to, writes us :

"The inclosed circular of Gritzner & Co. will give you a general idea of the lines Schmidt is working on. He divides his generator into three zones : 1st, Zone A, boiler proper, has very little heating surface, about 1 sq. ft. per H.P. generates wet steam. This goes into the lower pipes, which form the 2d Zone B, where the steam is dried ; it then passes into a vessel, *D*, and from *D* to the upper pipes which form Zone 3, and are marked *C*, to the engine. The wet steam at 9 atmospheres leaves the boiler at a temperature of 182° C., passes through the pipes *B*, at 230° in the vessel *D*, the water carried over by the steam flashes into steam and leaves *D*, to enter the superheater proper, *C*, at a temperature of 180° or some 50° less than when it entered *D*. After passing *C*, it enters steam-chest of the engine at a temperature of 340°. It is to be observed that the steam enters the superheater at the highest point where the temperature of the waste gases is lowest (250°), and leaves the superheater where their temperature is highest. This point is very important, as it extracts the heat very effectually from the waste gases as they enter the chimney at the low temperature of 250°.

"The engines are single-acting, fitted with long pistons after the fashion of the gas-engine piston. This is necessary in consequence of the great heat of the steam ; with this precaution no difficulty is experienced with pistons or cylinders. The heating surface of the superheater and steam drier is four times as large as the wetted surface of the boiler. The 150 H.P. engine is fitted with double heat valves of the Sulzer type. You will agree with me that the Schmidt motor is a very original scheme.

"This subject is being steadily investigated over here. I was present at the trials of one of these engines, made by my friends, Messrs. Gritzner & Co. The engine is of 150 H.P., and runs at 150 revolutions per minute. The trials lasted three days, and were superintended by Professor M. Schröter, of Munich. A consumption of feed-water of 4.6 kilograms (10.3 lbs.) per indicated H.P. was found. This beats the best records obtained by Sulzer's or the Allis Company with triple-expansion engines. The engine is a compound condensing, not particularly well built either. Small non-condensing engines built by the same firm on the Schmidt principle show a consumption of feed-water per *brake* H.P. of about 8 kilograms (17.8 lbs.). This is most extraordinary for engines under 20 H.P."

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

The object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publications will in time indicate some of the causes of accidents of this kind, and to help lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with the information which will help make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a great favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in December, has been compiled. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS IN DECEMBER.

Rochester, N. Y., December 1.—Robert Watt, fireman, and John Evans, engineer, were badly scalded by the collapsing of a tube on their locomotive while hauling a passenger train on the New York Central & Hudson River Railroad, near Grimesville this morning.

Lockport, Pa., December 2.—A collision occurred near here on the Central Railroad of New Jersey this morning between a coal and a freight train. The engine of the coal train was ditched, and the engineer, George W. Hull, was pinned beneath it and instantly killed. Lewis Gordon, the fireman, had both legs broken, and will probably die.

Alexandria, Va., December 3.—An engine hauling a local train on the Pennsylvania Railroad from this city to Washington jumped the track on the Long Bridge this morning. It plunged down a slight embankment and pinned Fireman W. T. Walker beneath it, killing him instantly. The engineer went down with the engine, but escaped with a slightly cut head.

Wilmington, S. C., December 6.—A collision on the Carolina Central Railroad occurred near Rockingham this morning between a freight train and a mixed passenger and freight train. Ellis Wells, engineer of one of the trains, was scalded to death, and the engineer of the other train was fatally injured.

Hartford, Conn., December 6.—A collision occurred on the New York & New England Railroad at this point this morning between a passenger train and a switching engine, in which Engineer Lewis of the switching engine was crushed to death,

Chicago, Ill., December 6.—There was a collision between a freight train on the Chicago & Erie Railroad and a Belt Line freight at Seventy-ninth Street this morning. Engineer Williams, of the Erie, was seriously hurt about the spine.

Lafayette, La., December 8.—There was a collision between two trains on the Southern Pacific Railroad at Duson Station this morning. Engineer Daniels was slightly hurt about the face.

Oil City, Pa., December 10.—A freight train on the Western New York & Pennsylvania Railroad ran into a landslide near here this morning. Engineer Kirkman and his fireman were buried in the *débris*, but escaped with their lives.

Atlanta, Ga., December 9.—There was a collision this evening between a passenger train and a freight on the Southern Railroad near Bellwood Avenue. The fireman, Robert Pitman, was badly injured in the side and head, and John Dorman, the engineer, was hurt about the head and arms.

Seattle, Wash., December 11.—An express train on the Great Northern Railroad ran into a landslide to-night near Everett. Fireman Delis was fatally injured by the hot water and steam.

Massillon, O., December 10.—A. R. Johnson, an engineer on the Wheeling & Lake Erie Railroad, was instantly killed at Warrington to-day. He was leaning from the gangway of his engine looking at the tender trucks when his head was struck by a bridge, and he was thrown into the creek below.

Holland, Tex., December 12.—Engineer Young, on the Missouri, Kansas & Texas Railroad, was mysteriously injured to-day by being struck with a stone or piece of iron. Four negro tramps, who were stealing a ride at the time, were arrested on suspicion of having been the cause.

Bristol, Tenn., December 11.—A fireman on the Norfolk & Western Railroad was killed near Egleston, Va., to-day by being struck by the projections of the tunnel near that point. He was leaning out of the cab window at the time.

Milledgeville, Ga., December 12.—A train on the Central Railroad of Georgia went through a trestle near here this morning. The fireman was scalded to death, and the engineer was so severely scalded that he died of his injuries. The accident was caused by the washing out of the foundations by high water.

Pittsburg, Pa., December 13.—F. B. Fogle, a fireman on the Pennsylvania Railroad, was blown from his engine by a high wind at New Florence to-day. He was killed by the fall.

East Somerville, Mass., December 15.—Charles Waterman, an engineer on the Boston & Maine Railroad, was struck by a passing train at this place to-day and very seriously injured.

Bridgeport, Conn., December 16.—In attempting to avoid a collision, John Gates, an engineer on the New York, New Haven & Hartford Railroad, had an arm broken and received several severe cuts on the head. His injuries were caused by jumping from the engine before it had stopped.

Houston, Tex., December 16.—Two freight trains on the Southern Pacific Railroad collided in heavy fog this morning. Fireman Clements was fatally hurt.

Indianapolis, Ind., December 17.—William Armer was severely injured by being struck by some obstruction as he was leaning out of the window of the cab. The accident occurred on the Big Four Railroad, and the obstruction is supposed to have been a semaphore signal post.

Wilkesbarre, Pa , December 18.—A misplaced switch on the Lehigh Valley Railroad sent a passenger train into a lot of coal jimmies on a siding. Fireman Harry Stevens was badly squeezed about the hips. Engineer Harry Warren escaped with a cut on his face.

Port Jervis, N. Y., December 21.—Michael Kelly, an engineer on the New York, Lake Erie & Western Railroad, was badly scalded about the face and neck by the bursting of a gauge glass this morning.

Little Rock, Ia., December 21.—An express train on the Iron Mountain Railroad was wrecked here to-day by running into a cow. Engineer Stansbury and Fireman Trendley were caught in the wreck and severely though not fatally injured.

Spokane, Wash., December 22.—A passenger train on the Oregon Railway & Navigation Line struck a soft place in the track to day, causing the rails to spread. The train was a double header, and both engines were ditched. Engineer Walker was pinned beneath the wreck, and so badly scalded that he died soon afterward. The other engineer and one fireman had each one leg broken and received internal injuries.

New Orleans, La., December 23.—At midnight to-night there was a rear-end collision at Viot, on the Southern Pacific Railroad, when a freight train ran into a passenger train. Fireman C. Russell, of the freight, jumped and was killed.

Lafayette, Ind., December 24.—Two freight trains on the Big Four Railroad collided about three miles from here this morning. Engineer Elijah Campbell was buried under the wreck of his engine and killed.

Prescott, Ariz., December 24.—A broken rail on the Atlantic & Pacific Railroad caused the wrecking of a passenger train near here to-day. The engineer was slightly injured.

Waxahachie, Tex., December 25.—There was a collision on the Dallas & Texas Central Railroad at this point to-night. Engineer Bob Mays had both legs hurt.

Nashville, Tenn., December 25.—A bad wreck was caused on the Louisville & Nashville Railroad south of here to-night by some cars that had run out from the siding to the main line. Engineer Daniel Shugart and Fireman Steve Pettit are seriously scalded. It is supposed that the cars were run out by some train wrecker.

Chicago, Ill., December 29.—In a rear-end collision on the Chicago, Burlington & Quincy tracks to-night, Richard Walsh, a fireman, was badly scalded and had both legs crushed.

Tacoma, Wash., December 30.—In a collision between a gravel train and a hand-car near Olequa to-day, on the Northern Pacific Railroad, Fireman D. A. Ames was killed.

Topeka, Kan., December 29.—The side rod of an engine on the Atchison, Topeka & Santa Fé Railroad broke near Peabody this evening. It tore away one side of the cab and hurled the engineer to the ground. He received five or six scalp wounds on the side and back of the head, and was bruised about the head, body and legs.

Knoxville, Tenn., December 30.—An arch pipe on an engine on the Southern Railway exploded near Sweetwater to-night and scalded the engineer, John W. Ramsey, so badly that he died from the effects.

Our report for December, it will be seen, includes 32 accidents, in which 11 engineers and 9 firemen were killed, and 17 engineers and 9 firemen were injured. The causes of the accidents may be classified as follows :

Blown from engine	1
Broken rail	1
" side-rod	1
Bursting arch-pipe	1
" gauge-glass	1
Cattle on track	1
Collapsed tube	1
Collisions	11
Derailments	1
Jumping from engine	1
Landslides	2
Misplaced switch	1
Running into hand-car	1
Run over	1
Spreading rails	1
Struck by missile	1
" " obstruction	3
Train wreckers	1
Trestle washed away	1
Total	32

PROCEEDINGS OF SOCIETIES.

Central Railway Club.—At the January meeting the Committee on Freight-car Doors and Hangers made a report, supplementing that presented at the December meeting.

Engineers' Club of Philadelphia.—At the December meeting Mr. John L. Gill, Jr., read a paper on boiler explosions, in which he exhibited and explained a table showing the energy stored in boilers of different types, dimensions and horse powers, and the height to which this energy could throw the boiler, with its weight of water, if allowed to act through an explosion.

Engineers' Club of St. Louis.—At the January meeting Colonel E. D. Meier read a paper on Chimneys and Chimney Drafts. The subject was considered with special reference to modern boiler practice and American coals. Computations usually made of stack capacity assumed the chimney gases to be of the same specific gravity as air. This is not true, as when combustion is complete the gases are really a mixture of carbonic acid gas, nitrogen, and steam ; the proportions varying with different coals. As these require different amounts of air, the varying weights of the gases of combustion cause a difference in the draft power of the same chimney. It is rare that just the proper amount of air is admitted, and there is a loss when the amount is too little or too great. Very often there is a surplus, reaching sometimes as high as 100 per cent. Tables were presented showing these facts clearly for five well-known coals : Anthracite, New River, Youghiogheny,

Mount Olive, and Collinsville. Computations were made showing how the capacity of a chimney could be increased much beyond the normal by raising the temperature of the gases, the result always being accompanied by a corresponding loss in efficiency. It was shown that the same capacity could be obtained without loss of efficiency by increasing the height of the chimney. A table was given showing the changes in the capacity of a given chimney by varying the temperatures of the gases; also the change of height necessary while maintaining a constant temperature. Another table showed the effect of different coals on the velocity of the gases, and on the areas of chimneys, the velocity being kept constant. The chimney formulæ of Smith, Kent, and Gale, and the experiments of De Kinder, were discussed. A table was given showing appropriate heights and areas of chimneys for powers from 75 H.P. to 3,100 H.P., assuming 7 lbs. of water evaporation per pound of coal, and 5 lbs. of coal per H.P. per hour. The effect of long flues leading to chimneys was also discussed. It was shown that where a number of boilers were to be connected to the same stack, its dimensions could be reduced proportionately after the first few boilers, as they would never all be fired at the same time.

American Railway Master Mechanics' Association.—The Secretary has sent out a number of circulars issued by the committees that have been appointed to report at the June convention. They are, in substance, as follows:

THE CAUSES OF BULGING OF FIRE-BOX SHEETS.

Is the difficulty caused—

1. By accumulation of mud or scale, preventing the sheet from receiving the necessary protection of the water?

2. Insufficient water space, preventing free circulation, and tending to drive water from sheet?

3. Bad water—that is, water containing such impurities and other hurtful substances, producing excessive foaming and tendency of water to leave the sheet?

4. Do you consider that the fact that the inside of the sheet is hotter than that next to the water has any influence on the bulging of sheets? If so, can you suggest a practical remedy?

5. Does the spacing of stay-bolts have anything to do with the bulging of sheets? Do you consider that closer spacing would provide a partial remedy?

6. Have you noticed that the use of oil in boilers to neutralize the evil effects of bad water has had a tendency to increase the bulging of sheets? In stationary boilers there has been an insoluble soap, formed by oil and water impurities, deposited on furnace sheets, which caused over-heating. Has anything of this character been noticeable by you in locomotive boilers?

7. Have you any reason to believe that the variation of temperature between the outside and inside of sheets has had anything to do with the breaking of stay-bolts?

In sections where bad water is prevalent, experience has led to a constant fight to keep boilers clean, and when very little neglect shows itself in the bulging of sheets and other serious results, it seems wise and helpful to get all the practical experience possible, with a view to broadening the scope of the committee's inquiry; and any information relative to the subject, or concerning (*a*) methods of preventing fire-box sheets from bulging, or (*b*) how to take care of boilers in bad-water districts, will be pertinent and very acceptable.

Answers to be sent to P. Leeds, Superintendent of Machinery, Louisville & Nashville Railroad, Louisville, Ky.

RIVETED JOINTS.

The committee especially request that the information furnished should apply only to the latest practice, and should not include data relative to old styles and types, unless such joints represent present practice. To facilitate the work of the committee, it is especially requested that all information called for in the first ten items on a drawing or tracing 8¼ × 10¾ in. in size, showing only one joint on each drawing or tracing; all joints used should be furnished and every drawing should be fully dimensioned. A sufficient amount of each joint should be shown to enable a calculation to be made of its efficiency, hence please show not less than three rivets of the row with greatest pitch. 1. Thickness of stock plates or sheets. 2. Thickness of inside butt or welt strips. 3. Width of inside butt or welt strips. 4. Thickness of outside butt or welt strips. 5. Width of outside butt or welt strips. 6. Diameter of rivet or rivets. 7. Diameter of rivet hole or holes. 8. Distance from edge of stock and welt sheets to centre of first row of rivets. 9. Distance between each row of rivets. 10. Distance (pitch) between each rivet on each row. 11. Are rivet-holes punched or drilled? 12. If sheet is punched or drilled, do you remove the burr from the edge of the hole before assembling the sheets? 13 Do you ream the rivet-holes after assembling the various sheets? 14. In punching your sheets, do you punch them so that the smaller diameter of the holes will be together when assembled, or *vice versa?* 15. Do you use iron or steel rivets? 16. Do you single or double-rivet the mud-ring? 17. Do you consider it advisable to double-rivet the circumferential seams of a locomotive boiler? If so, why? 18. Have you ever seen the joints in a fire-box double-riveted? 19. Have you ever made any physical tests of riveted joints? If so, please give us the results obtained, and how closely the results compared with the calculated strength.

The committee would also be pleased to receive information relative to your practice in riveting domes, mud-rings, boiler heads, fire-door and other sheets in a boiler, and your reasons for adopting such practice. In order that the committee may have ample time to compile and work up its report, kindly have all replies forwarded not later than February 15, to A. E. Mitchell, Superintendent of Motive Power of the New York, Lake Erie & Western Railroad, 21 Cortlandt Street, New York City.

BEST MATERIAL FOR BOILER TUBES.

The committee desires a full expression of opinion, and propounds the following questions:

1. What is the best material for locomotive tubes? 2. Please give your reasons for this preference. 3. In ordering tubes, do you furnish specifications? If so, please send a copy of same. 4. In your opinion, would a tube made of a *fair quality* of material, combined with a safe end made of a *good quality* of material, answer for all practical purposes? 5. What is the maximum length of locomotive tubes of different diameters? 6. What should be the thickness of metal for tubes of different diameters? 7. How often may tubes be pieced out with advantage and safety? 8. When and for what causes should tubes be condemned? 9. How do you test tubes and safe ends? 10. In making specifications for tubes, is the effect on them of the water used taken into consideration? 11. Describe your methods of fastening tubes at front and back end, say whether copper ferrules, and what kind of tools are used for caulking and turning over the ends of tubes.

Please answer these questions, and mail same to T. A. Lawes, Mechanical Engineer of the Chicago, Cleveland, Cincinnati & St. Louis Railway, Indianapolis, Ind.

Prizes for Railroad Inventions.—The Verein of German Railroads has appropriated 30,000 marks ($7,500) to be distributed in prizes every four years for remarkable inventions and important improvements that are brought out in the domain of the railroad service. These prizes are to be divided as follows:

A. For inventions and improvements in the domain of construction and mechanical equipment of railways: A first prize of 7,500 marks; a second of 3,000 marks, and a third of 1,500 marks.

B. For inventions and improvements in the domain of the methods of operation, and that of the maintenance and development of the methods of operation. A first prize of 7,500 marks, a second of 3,000 marks, and a third of 1,500 marks.

C. For inventions and improvements in the domain of the administration and the operation of railroads, as well as that of railroad statistics, and for valuable literary work in the province of railroad work of all kinds. A first prize of 3,000 marks, and two second prizes of 1,500 marks each.

Without desiring to exclude from the competition other inventions and improvements appertaining to the railroad service, and without desiring to limit the commission in the examination of things that may have an influence on their decision, the following subjects have been selected as being especially worthy of consideration:

(*a*) Improvements relating to the construction of locomotive boilers, especially such as have for their object, without any great increase of the dead weight, a greater safety against the dangers of explosion, a better utilization of the fuel, lessening the amount of sparks that are thrown, and a saving in the expense of maintenance.

(*b*) Manufacture of strong and durable hose for conveying steam and compressed air for the rolling stock.

(*c*) An arrangement for permitting the trainmen to safely couple cars equipped with the American automatic coupler and the standard coupler of the Verein.

(*d*) Construction of a practical and cheap brake for freight cars.

(*e*) An automatic arrangement that will prevent the displacement of switch points during the passage of a train.

(*f*) An apparatus that is not complicated, for signalling when the entire train, including the very last car, has passed the switch points.

(*g*) A system of weighing that will permit of the weighing of cars in motion, whether detached or in a train.

(*h*) A proposition for the simplification of the accounts of the interchange of rolling stock.

If in any of the three groups the commission cannot decide on the allotment of the first or second prizes to any invention or improvement that has been presented for its consideration, the examining commission can divide the sum allowed for this first or second prize in the group in question, so as to grant several second or third prizes. Furthermore, the sum allotted to any one group may be divided among the others.

The conditions are as follows :

1. Only those inventions and improvements are admissible that have been brought out during the term specified below.

2. To be admitted to the competition, the invention or improvement must have been put into use before application upon one of the railroads forming a part of the Verein of German railways, and the request to enter the competition must be seconded by this railroad.

3. The project must be accompanied by a detailed description, together with drawings and models, etc., so as to convey to the judges a complete knowedge of the kind and nature of the device, the possibility of its operation, and the efficiency of the invention or improvement in question.

4. The obtaining of a prize shall not prevent the inventor from exploiting or soliciting a patent. Furthermore, each candidate for a prize for inventions or improvements must submit to the officers of the Verein a statement of the conditions upon which he will concede to it the right to use the invention or improvement.

5. The Verein has the right to publish the successful inventions.

6. All literary works submitted must be in triplicate. One of the copies will be placed in the library of the Verein, the other two will be returned to the candidate if he shall make a formal application for them.

7. The applications must contain the proof that the inventions and improvements have been brought out and the literary works published during the period named below. A commission composed of twelve members will be appointed by the Verein to examine into the projects that are presented, and decide whether the prizes are to be awarded and to whom. The first award will embrace all inventions and improvements that have been brought out between July 16, 1887, and July 15, 1895. Therefore all inventions and improvements that are to be presented to the commission must be executed before the date mentioned. The same statement also applies to all literary works. All applications should be sent, free of all charges, to *Kranoid*, in care of the Verein, at No. 3 Bahnhofstrasse, S. W. Berlin, Germany, between January 1 and July 15, 1895.

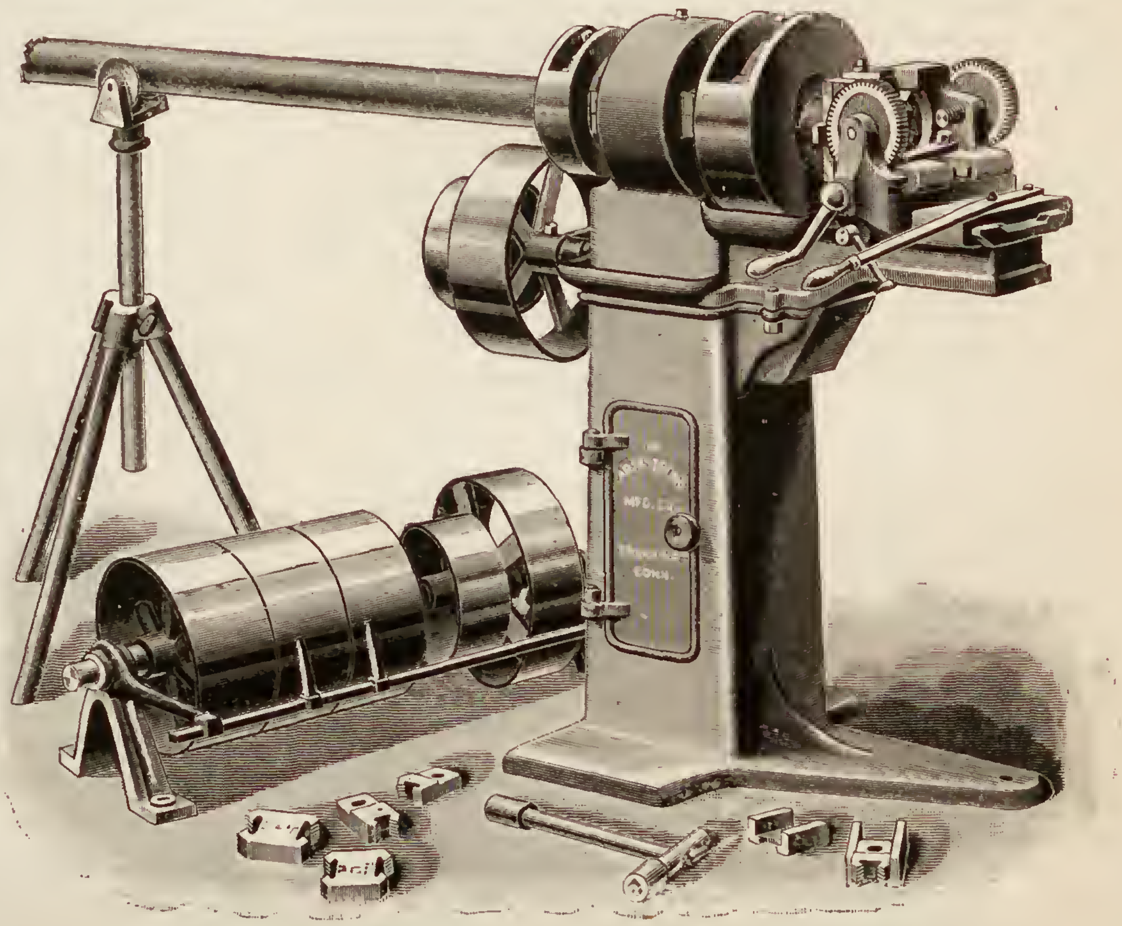
ARMSTRONG PIPE-THREADING AND CUTTING-OFF MACHINE NO. 2½.

Steam-fitters and others having to do with the cutting and threading of pipe will find in this machine a most convenient tool built for their especial line of work. It is an improved form of the No. 2 pipe-threading and cutting-off machine for hand or power, built by the Armstrong Manufacturing Company, Bridgeport, Conn., and retains the many attractive features of that machine in addition to others peculiarly its own. It is very compact, rigid and durable, and does not require the services of a skilled operator. All of the gears and working parts are enclosed in an oil-tight chamber, which insures their perfect lubrication, and effectually keeps out dust, dirt and chips which might otherwise get to them and thus interfere with the perfect working of the machine.

In one particular this machine differs essentially from all other pipe-cutting and threading machines of its class built by the Armstrong Company. In its operation the *pipe* revolves instead of the dies, being held securely by tight-gripping chucks.

For radiator steam coil works, etc., and other services where the greater number of pipes are of comparatively short lengths, this will be found a particularly desirable arrangement. The dies and cutting-off tool are held stationary, and are opened and closed by means of a double-geared crank-handle, as shown. Expanding dies are used in connection with a self-centring and powerful gripping chuck, insuring speed in cutting off and threading a pipe. They are furnished to thread from 1 in. to 4 in. inclusive.

Quick interchangeability of the various sizes of dies, coupled with a construction which permits of separate adjustment for three different sizes, enables the operator to thread pipe to suit all variations in ordinary fittings, and to open and close the dies any number of times without changing the adjustment. Again, either of the sizes may be used alternately without change of adjustment, or the dies may be quickly taken out to permit of the free passage of the pipe to be cut off, and the adjustment still remain unchanged. An objection frequently raised against machines using expanding dies is, "Our men are not skilful enough to use expanding dies without threading some of the pipe too large and some of it too small."



ARMSTRONG PIPE-THREADING AND CUTTING OFF MACHINE.

This has been met and successfully overcome in the tool here shown. Though the dies are quickly opened after threading a piece of pipe, yet they may be as quickly closed together again without the least danger of variation, unless intentional.

The weight of this machine is about 700 lbs.; with counter-shaft, 850 lbs. Speed of counter-shaft should be about 225 revolutions a minute.

Recent Patents.

FARNSWORTH'S GAS-COMPRESSING PUMP.

The objects of this invention are to reduce the height of a vertical machine, to facilitate access to the parts and relieve the foundation of strains ; to reduce to a minimum the angularity of the connecting-rod during the latter part of the stroke, and to improve various details of construction.

In the accompanying drawings, fig. 1 is a side elevation of a double cylinder compressor embodying my improvements, fig. 2 is a vertical section thereof, and fig. 3 is a cross-section on the axis of the rock shaft.

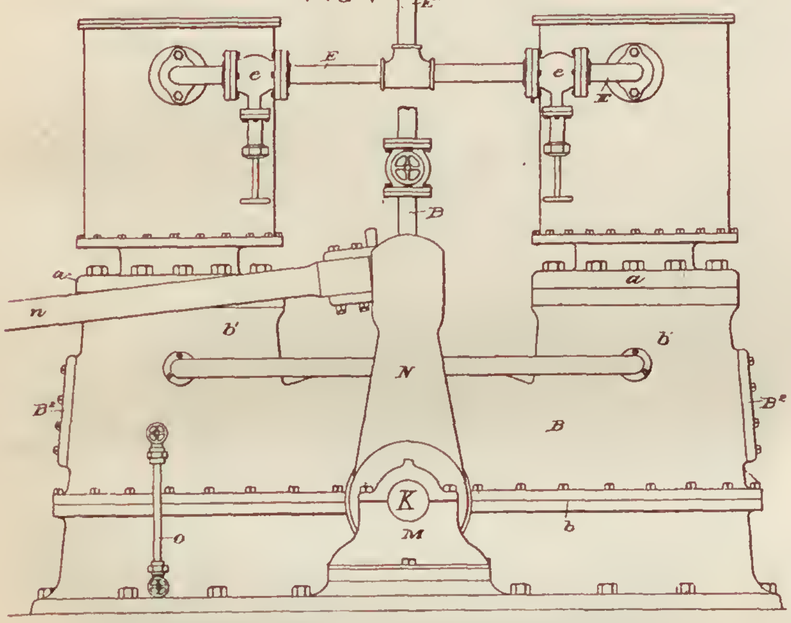
The cylinders *A A* (fig. 2) are open at each end, and are supported by flanges *a* on a suitable base, *B*, consisting of preferably two parts united by a packed joint, *b*, on a horizontal plane. The upper portion of the base has two necks, *b'*, in which the cylinders are received, their lower ends depending into the base, as shown. The joint between the neck *b'* and the flange *a* is packed, so that the base forms a gas-tight chamber. A pipe, *B'*, provided with a suitable stop valve, con-

nects the base with the evaporating coils. The lower portion of the base is preferably in one piece, to form a reservoir for lubricating oil. At B^2 are covers to hand-holes for giving access to the bearings of the connecting-rods. In each cylinder, just below the flange a, are one or more ports, a'. The upper end of each cylinder is closed by a check-valve, C, which cuts off the cylinder from a chamber, D, from which proceeds a discharge pipe, E, having a stop-valve, e, and connecting with a common pipe, E', running to the condenser.

In each cylinder is a piston, F, tubular in shape, and provided with a number of packing rings, f. The upper end of the piston forms a seat for an upwardly closing valve, G, which slides on vertical guides, f', on the inside of the piston. A ring, f^2, screwed into the lower end of the piston limits the play of the valve. A socket is formed in the under side of the valve to receive the ball h on the upper end of the connecting-rod H, the ball being confined in the socket in any suitable manner, as by a gland, g. The lower end of the rod H is provided with brasses, h', for connecting it with a wrist-pin, i, on a rocker, I. The brasses can be adjusted by a wedge, h^2, and screw, h^3.

The rocker I is keyed to a shaft, K, journalled in bearings b^2 integral with the lower portion of the base. The rocker has a working fit between the inner faces of these bearings, which are bored out cylindrically, and are lined with bushings, L, turned to an outside fit in the bearings and bored out to suit the long and preferably taper journals k on the shaft K. A gas-tight cover, b^3, incloses one end of the shaft. The other end passes through a stuffing-box, B^3, and is supported in an outboard pillow-block, M. The axis of the shaft lies preferably in the plane of the joint b between the upper and lower portions of the base. Fastened to the shaft outside the base is

FIG 1



FARNSWORTH'S GAS-COMPRESSING PUMP.

a rocker arm, N, to which may be attached a rod, n, for connecting it with an engine or other motor.

The wrist-pins i and shaft K are not in line with each other, but the shaft stands above the line joining the pins, so that each pin is distant from the shaft more than half the distance between the axes of the cylinders A. The proportions are such that when a piston is at the bottom of its cylinder, as at the right of fig. 2, the angularity of the rod is the greatest; but when the piston has made half its up-stroke, the pin i intersects the axis of the cylinder, and the rod coincides with said axis. The continued upward movement of the rocker arm swings the rod slightly outward for the next quarter of the stroke, but during the last quarter the rod again approaches a central position, which it reaches at the end of the stroke, as seen at the left of fig. 2. The dotted lines in this figure show the paths of the pins i. It thus appears that during the latter half of the stroke, when the resistance of the gas in the cylinder is greatest, the angularity of the rod is least, thus reducing to a minimum the wear and strain. It also appears that the line joining the centre of the wrist-pin and the axis of the shaft does not stand at right angles to the axis of the cylinder until three-quarters of the stroke has been made.

In operation, the downward movement of the rod H first draws down the valve G from its seat in the upper end of the piston. When the lower end of the valve strikes the ring f^2, the piston is carried downward, the gas in the base passing into the cylinder past the open valve G. On arriving at the bottom of its stroke the piston uncovers the ports a', which permit the gas to enter the cylinder freely and insure a full charge at evaporating pressure. The upward movement of the rocker arm first closes the valve G and then carries up the piston, compressing the gas in the cylinder until it equals the pressure in the condenser, when the check-valve C opens, and the gas passes into the condenser, where it is liquefied. The construction of the piston is such that there is perfect freedom from restraint, avoiding unequal wear, and insuring prompt and correct action. The ball joints, guides in the pistons, pins and shaft bearings are all lubricated by the oil in the lower portion of the base, which is preferably carried at

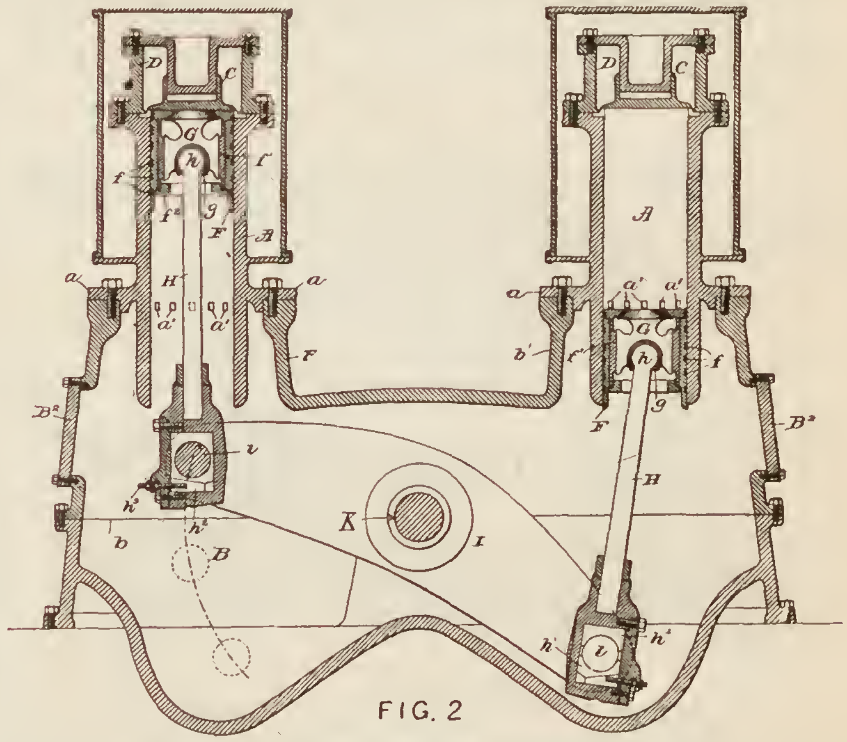


FIG. 2

FARNSWORTH'S GAS-COMPRESSING PUMP.

the height of the centre of the shaft K, but may be varied to suit. The level of the oil is shown by a gauge, O. At each stroke the descending rocker arm throws up a spray which amply lubricates the parts not immersed in the oil.

The inventor is Mr. Thomas Farnsworth, of San Antonio, Tex. His patent is numbered 530,097, and dated December 4, 1894.

THE HINCKLEY SLACK ADJUSTER FOR RAILROAD CAR BRAKES.

There are principally two methods for automatically taking up or compensating for the wear and consequent slack due to

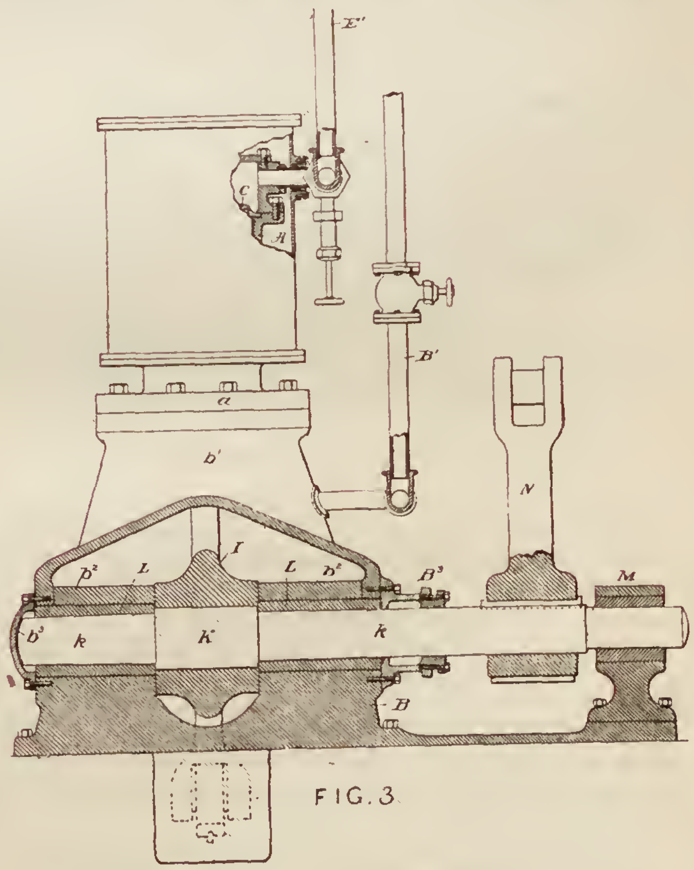


FIG. 3

FARNSWORTH'S GAS-COMPRESSING PUMP.

the wearing away of brake-shoes. One is to shorten up some of the connecting-rods when the shoes have been worn; the other is to adjust the fulcrum or fulcra of one or more of the levers as the wear of the shoes increases.

The invention illustrated herewith has reference particularly to the latter method, and consists generically in interposing between two levers of the system a connection which, so long

as the throw or extent of movement of the levers is normal, will remain inactive, but which, when the movement of the levers, or either of them, increases by reason of slack in the rigging, operates to shift the fulcrum of the lever which has a stationary fulcrum.

Specifically the invention consists in connecting the live lever 2 and the dead lever 1 together by means of a rod, 5, having a connection with one of the levers which allows it to move independently of the lever in one direction, and causes it to carry the lever with it when moved in the opposite direction, and which rod is automatically extensible so that any increase in the movement of the live lever due to slack will cause the dead lever to shift its fulcrum.

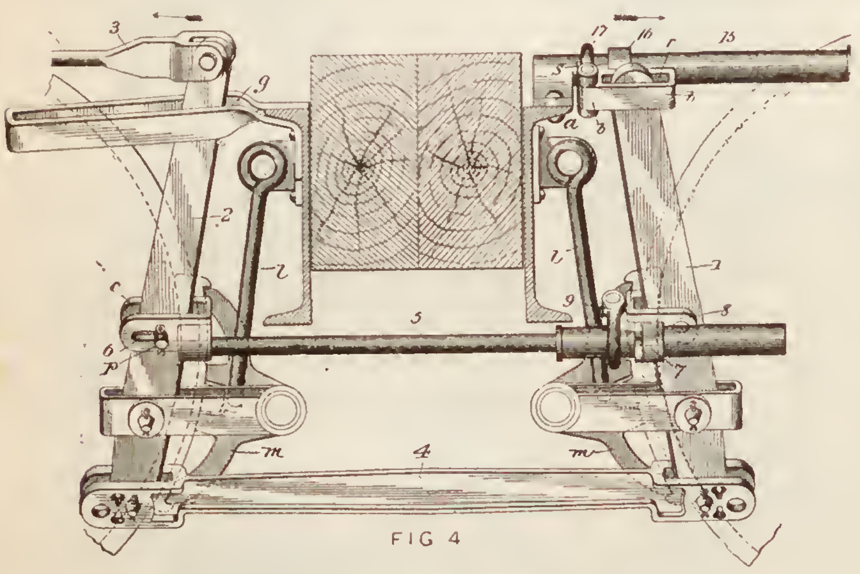


FIG 4

THE HINCKLEY BRAKE SLACK ADJUSTER.

Fig. 3 is a side view, in which 1 indicates what is commonly known as the dead lever; 2 the usual live lever; 3 a portion of the brake operating rod; 4 a connecting-rod securing the two levers together for operation in the ordinary manner.

15 denotes a guide-rod and support for the adjustable fulcrum of the dead lever 1. It is firmly bolted at its inner end to any convenient part of the truck or framing, as indicated in the drawings at *a*, and is preferably made hollow or tubular for lightness and strength. A sleeve, 16, encircles this guide-rod and slides freely to and fro thereon, and the outer end of the rod is preferably provided with a flange, *f*, to prevent the sleeve from going off the end of the rod. Cast or formed integrally with this sleeve is a fulcrum block, *b*, having a recess or opening, *r*, therein to form a keeper for the upper end of the dead lever. This block carries an automatic gripping device which permits it to move along the supporting rod freely in one direction, but which grips and binds the block to the rod and prevents it from moving in the opposite direction. The gripping device consists of a loop or shackle, 17, pivoted upon the block and encircling the guide-rod, stops *s* being formed on the block to prevent the shackles from swinging past a line perpendicular with the face of the block in one direction. When the loop rests against these stops the fulcrum block is free to move outwardly on the supporting rod, but any movement of the block in the opposite direction will cause the shackle, which, as will be understood, fits the surface of the rod rather snugly, to grip and bind upon the rod, thereby forming a positive lock or stop against reverse movement of the block.

5 indicates a connecting-rod between the live and dead levers, which, in connection with the said levers and the automatic gripping devices hereinafter described, constitutes the adjuster proper. This rod is pivotally connected to the live lever in any suitable manner so as to move longitudinally as the lever swings backward and forward. It is preferable to connect the lever with the rod, so that it (the lever) may have a certain movement independently of the rod, and this connection is shown in the drawings as formed by means of a pin, *p*, in the lever which passes through a slot, 6, in the clip or stirrup *c* secured to the end of the rod and forming the immediate connection between it and the lever.

Pivoted to the dead lever is a stirrup or clip, 8, preferably similar in general structure to the clip *c* on the live lever. The stirrup 8 has formed upon one side of it a sleeve, 7, into which fits the free end of the connecting-rod 5, so that the rod may have a sliding connection with the stirrup and the dead lever. The stirrup carries an automatic gripping device similar to that carried by the fulcrum block for the dead lever, except that it is arranged to permit the rod to slide freely through the stirrup in the opposite direction to that of the movement of the fulcrum block.

The operation of the apparatus is briefly as follows: When the brakes are applied, the rod 3 and the live lever move in the direction of the arrow. It is not intended that the adjuster-rod 5 should be moved by the live lever except when slack exists in the rigging. The loose connection between the lever and the rod heretofore described—viz., the pin and slot connection between the stirrup *c* and the lever—is therefore provided. When the shoes are new and there is no slack in the rigging, the lever will move to and fro without moving the rod, the slot 6 being of sufficient length to permit this in the normal throw of the lever. When, however, slack occurs, the increased movement of the lever carries the rod 5 with it, the gripping device on the stirrup 8 permitting the free end of the rod to slide through the sleeve 7. When the brakes are released the reverse movement of the lever 2 pushes back the rod 5, but at this time the shackle 9 binds upon the surface of the rod and grips it firmly to the stirrup, causing the dead lever 1 to move back with it. As heretofore described, the fulcrum carrying block for the dead lever is free to move outward along its supporting bar, and the thrust of the adjuster-rod 5 on the return stroke of the live lever 2 causes the dead lever to push the fulcrum in the direction of the arrow in fig. 1. These movements are repeated at every application of the brakes, but the adjuster rod and the dead lever are operated only when there is slack in the rigging.

Howard Hinckley, of Trenton, N. J., is the inventor. His patent is No. 531,034, and dated December 18, 1894.

BEGTRUP'S ENGINE CROSS-HEAD.

Figs. 5 and 6 represent a method for adjusting the shoes or slides of cross-heads designed by Mr. Julius Begtrup, of Ridgway, Pa.

A represents a cross-head of any approved construction, *B* is a piston-rod, and *C* the connecting-rod.

D are the shoes or bearings adapted to work in suitable ways or guides (not shown).

E represents oppositely projecting ears attached to the cross-head, having suitable bearings for an eccentric bolt, *G*, which passes through the ears and through an opening, *G*, formed in the shoe. The shoes are adjustably set in and out from the cross-head by means of the eccentric bolt *G* being

FIG 5

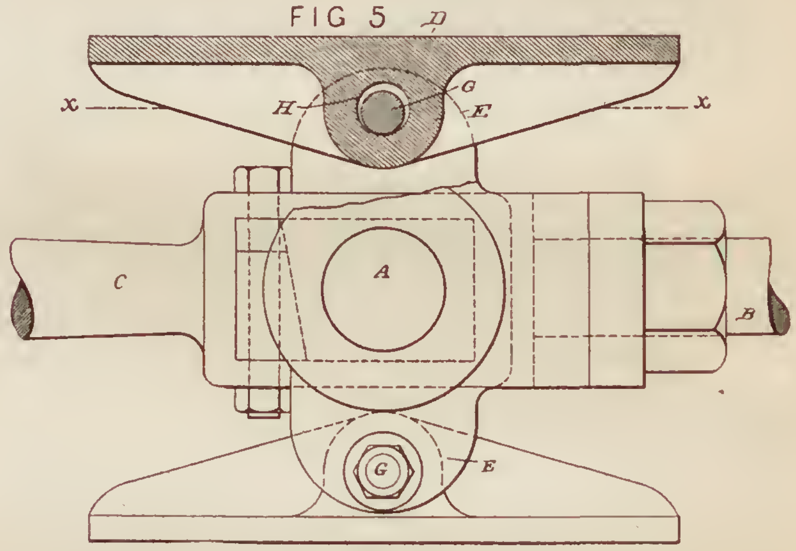
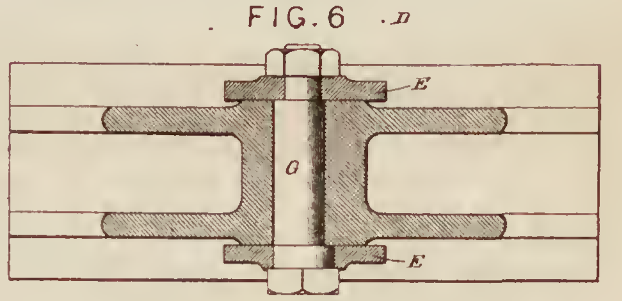


FIG. 6



BEGTRUP'S ENGINE CROSS-HEAD.

rotated to more or less extent, and then locked in that position by the lock-nuts upon said bolt, leaving the shoe free to oscillate upon the bolt.

In the cross-head shown in the present drawings each shoe is adjustably set by means of a single eccentric bolt, and the shoe has a rocking bearing adjustment in addition upon said bolt; but if desired, the shoe may not have a rocking bearing, and it may also be adjustably set by means of more than one bolt *G* for each shoe.

The patent is December 4, 1894, and is numbered 530,320.

AeronauticS.

Under this heading we shall hereafter publish all matter relating to the interesting subject of Aerial Navigation, a branch of engineering which is rapidly increasing in general interest. Mr. O. Chanute, C.E., of Chicago, has consented to act as Associate Editor for this department, and will be a frequent contributor to it.

Readers of this department are requested to send the names and addresses of persons interested in the subject of Aeronautics to the publisher of The American Engineer.

AERONAUTICAL NOTES.

A Snap-shot at a Gull.—Whoever has watched a soaring bird floating in the sky, riding upon the wind on rigid wings, and gliding about in all directions with scarce a change of attitude, must have wondered how he manages to set at apparent defiance all the laws of gravity and of motion, and longed to possess photographs of the bird in order to study his attitude at leisure.

A SNAP-SHOT AT A GULL.

Unfortunately the taking of such photographs is exceedingly difficult. The bird flits so rapidly, he is generally so far off, there is so seldom any neighboring object to guide the eye in judging of dimensions and positions, and the effects of perspective so frequently distort the attitude, that numerous as are the soaring birds at sea or in southern latitudes, adequate photographs of them are very rare.

We, however, engrave herewith "a snap-shot at a gull," taken by a young lady with a kodak camera, upon one occasion when all the surrounding circumstances were just right.

A Balloon Tour.—In the latter part of September of this year Mr. M. Mallet, the aeronaut who succeeded in 1892 in maintaining himself for 36 hours in the air in a balloon, and Mr. W. de Fonvielle, the veteran author and aeronaut, undertook what they called a tour of France by balloon, traveling by a series of ascents.

The balloon was of 37,500 cub. ft. capacity, weighing with its appurtenances 660 lbs., and capable of carrying three passengers. It was provided with an auxiliary storage balloon of 2,100 cub. ft. capacity, from which to replenish the main balloon, and also with the aerial screw invented by Messrs. Mallet and Langlois, to raise and lower the balloon, so as to economize ballast and gas.

A preliminary trip was made in the night of September 14. The wind was not in the desired direction, and, being violent, the aeronauts were blown 286 miles in about 10 hours, landing not very far from La Rochelle, whence they went back to Paris after emptying their balloon.

They started out again on September 19, and were blown about 40 miles northward, when they landed for the night. They started up again the next day, but went only a few miles in consequence of light and baffling winds. The next day rain set in, and for the next three days, although ascents were made daily, little progress was accomplished, the winds being so light and baffling that the aeronauts never got more than 100 miles from Paris. The seventh day they gave it up, and returned home determined to try it again later. The aerial screw was tested once, and found to raise and lower the balloon; but as it is rotated by hand, its use was found to be a good deal like work, and it was landed after the trial test.

Upon the whole, it may be doubted whether anything like a tour can be made by a balloon. It is the sport of the wind.

Paris Captive Balloon for 1900.—The French have had captive balloons at all their international expositions, and have demonstrated the fact that these can be so safely operated that they form popular and profitable attractions, no less than 15,000 passengers having made the ascension in the comparatively small captive balloon of 1889, without the slightest accident, and this balloon having subsequently made a free voyage with 20 passengers.

The following compilation shows the principal data pertaining to these captive balloons.

CAPTIVE BALLOONS IN PARIS.

Year.	Diameter.	Cubic Feet.	Passengers.	Height.
1867.......	?	176,000 ?	12	820 ft.
1878......	118 ft.	883,000	42	1,640 "
1888.......	59	107,800	14	1,400 "

Now the French are proposing to have a much larger captive balloon at the Exposition of 1900, and Messrs. L. Godard, E. Surcouf & J. Courty, aeronautical engineers, have designed one 144 ft. in diameter, to contain 1,590,000 cub. ft. of hydrogen gas, and to ascend to a height of 1,950 ft. with 160 passengers. It is to be controlled by a cable decreasing in diameter from 3.93 down to 4.71 in. in diameter, wound upon a drum by a steam-engine of 600 H.P. All the parts, including the universal pulley under which the cable passes, are designed with a factor of safety varying from 4 to 6.

The balloon is to have an internal air-bag, which is to be kept more or less distended, in order to maintain a uniform pressure upon the gas, so as to prevent deformations of the external envelope when variations occur in the volume or density of the gas.

The clear atmosphere of wood-burning Paris is particularly favorable for captive balloons, and it is to be hoped that this will be more fortunate than the captive destroyed in Chicago in 1893.

FLYING EXPERIMENTS.

To the Editor of The American Engineer :

Since the appearance of my article in the January number of your magazine, I thought it well if I would indicate the lines of my investigations. I have employed a surface of 200 sq. ft. in area, stretched on a bamboo frame, all in one piece and weighing 50 lbs. I have sailed a few feet, but not from any great height. My experience resulted the same as others who have sailed from greater elevations—*i.e.*, it must be propelled, as the wind cannot be depended upon as a motor. I concluded that if the above surface was cut up into strips about a foot wide and spaced a foot apart, extending out on each side of the operator like the wings of a bird, it would give greater lift in ascending currents of air, and less resistance to advance; with a narrow tail extending back would give equilibrium, but this latter would be attained only when the machine is advancing. Now in order to propel, I thought that by running and jumping into the breeze I could continue the motion of springing up and down after I left the ground, and so propel. The result of my experiments proved that I must first lift, then propel, and continue advancing to obtain equilibrium, regardless of whether the wind blows or not, or the place of starting is rough or smooth, before I could hope to evolve a successful machine which would go under all

conditions. I don't believe mathematical formula will help in this any more than it will help to ride a bicycle.

I will give results of present experiments later on.

CHARLES ZIMMERMAN, M.D.

FREDERICK, MD., January 14, 1895.

UNITED STATES WAR BALLOONS.

THE balloon park of the United States Army, or the headquarters for experiments and practice, is at present located at Denver, Col. The view which we give herewith is of the balloon ready for an ascent.

A UNITED STATES WAR BALLOON.

Efforts are now being made to get the needed authority for the construction of another balloon, and the following particulars in relation thereto are taken from the *Rocky Mountain News*, published at Denver. That paper says:

"General McCook has taken an active interest in the development of the signal service, as exemplified by Captain Glassford and his corps of assistants, and he is now urging the appropriation of a special fund for advancing the service. Before he retires from office, next April, the general desires to see a new war balloon in complete working order. Plans have been made by which the airship can be built in Denver at a cost of about one-third of that required in the manufacture of the *General Myer* in France. Captain Glassford estimates that, with the assistance of Sergeant Baldwin, he can turn out the balloon c mplete for $700. No such balloon as is contemplated has ever been made on this side of the Atlantic, and the process will be watched with great interest by aeronauts in all parts of the country.

"The object of having two war balloons in the signal corps is for the purpose of making exhibitions at different posts where the army is located, and giving signal men an opportunity to learn how to operate the balloons at different elevations and under various circumstances. Applications have been made at Washington by heads of the signal departments at San Antonio, Tex., and San Francisco, Cal., asking that the *General Myer* be sent to those points to be tested by the specialists of the department. The question at once presented itself, that if the balloon park is to be permanently located at Fort Logan one balloon could not fill the requirements, and it would be necessary to have at least two balloons at the command of the department if the field is to be satisfactorily covered. The plan which General McCook favors is for one balloon to be kept at Fort Logan and its companion to be sent over the country in charge of a competent officer. The hydrogen gas for inflating the balloons is to be manufactured at Fort Logan and shipped in iron cylinders to points where the perambulating balloon is on exhibition. The apparatus for manufacturing the gas is almost complete, and the first shipment of gas will be made in a few days. The tubes will be sent to Fort Riley, where the *General Myer* has been kept until experiments can be performed before the cavalry and artillery school. At the conclusion of the tests the balloon will be bundled up and sent to Denver, where it is to be permanently located."

The officers in charge of the balloon corps have, of course, kept themselves informed of all the experiments and investigations which have been made in aeronautical matters, and Captain Glassford, who is in charge of the United States balloons at Denver, is reported to have given as his opinion, after years of study of the subject, that the aeroplane will finally prove to be the solution of the vexed problem. The French dirigible balloons have not attained a perfection that entitles them, in the opinion of Captain Glassford, to serious attention when compared with the airship that has been developed by Maxim. The experiments of Maxim prove that a machine can be made sufficiently powerful and light to lift itself into the air. The experiments also prove that the aeroplane will lift a great deal more than a balloon of the same weight, and that it can be driven through the air, by means of a screw propeller, at a great rate of speed. Mr. Maxim takes the position that if the French balloon experts had spent half the money on aeroplane experiments that they have expended in fruitless attempts at making dirigible balloons, the flying machine would be as common as the torpedo-boat. The one feature in experimentation which Maxim has not reached is the attempt to steer the aeroplane through the air. In Sergeant Baldwin, who has had years of practical experience in riding in balloons and taking parachute flights through the air, Captain Glassford thinks he has a man who is especially adapted to make the supreme test. Captain Glassford furnishes the technical knowledge, and Baldwin puts the plans into execution.

Our Denver contemporary is authority for the statement that Captain Glassford "hopes to be able to take up the flying machine at the point it has reached through the remarkable experiments of Hiram S. Maxim, and build a machine that

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will carry a navigator through the air and at the same time will be under full control."

ON THE PROBLEM OF AERIAL NAVIGATION.

In our last issue we published an article by William Bosse on this subject, in which a reference was made to engravings that were inadvertently omitted. We therefore reprint that portion of Herr Bosse's article referring to the engravings, together with them.

This constitutes the wing-frame, which is now covered with some light stuff, which latter must project somewhat over the rear end of the ribs; such wing surface being intended to yield to the air pressure more and more toward its rear edge. Of course the coupling-rods are not covered, as that would interfere with the free display of the elasticity of the wing surface. If now this pair of wings—one on each side of the vehicle—is so connected with the treadle that with the downward movement of the treadle the wings are also moved downward, the main requirements of the system are given.

The accompanying drawings illustrate the intended wing motion as follows:

Fig. 1, *a* is a rigid portion of the wagon; *b b* are two equal cranks, rotating as indicated, and raising and lowering the bar and "wing-carrier;" *c*, which, while in motion, remains parallel to the ground plane.

Fig. 1

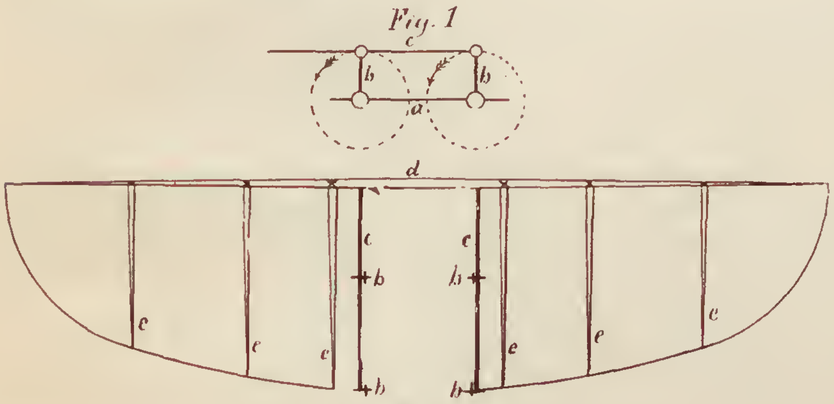

Fig 2

Fig. 2 shows the wings on both sides of the wagon, to wit: *b b*, the crank pins (?); *c c*, the "wing-carriers;" *d*, the cross-beam, or main wing-arm, to which the wing-surfaces are attached, and extended over the elastic ribs *e e*.

The surfaces are slightly curved upward, but, owing to their elasticity, are deflected upward during the down-stroke, so that a considerable component of the "push" causes the wings to rise again, under the influence of the forward motion, like a kite inclined at a very small angle; this play continuing on and on.

SOARING FLIGHT.

Although I do not take the same view in explaining the flight of soaring birds as Professor Langley so ably advanced in his article on the "Internal Work of the Wind," I would nevertheless like to suggest that Professor J. B. Johnson has allowed a very considerable error to creep into his discussion of the paper. If we make the same assumptions, a wind alternating between 25 and 35 miles per hour every 10 seconds, and an average acceleration and retardation in the bird's speed of 1 ft. per second, it is then quite true that the *relative velocity varies from nothing to five miles per hour, and that its average is about three miles per hour.* This much is quite correct, but the *sustaining value* of that relative wind is not equivalent to a wind of only 3 miles, because the sustaining value of two winds does not vary as the first power of their ratio, but as some higher power, which possibly exceeds the square, and therefore that relative 3 miles is equivalent to a wind of $\sqrt{33^2 - 30^2} =$ 13.75 miles per hour in its sustaining effect.

Now, an albatross is generally believed to be able to breast and advance against a gale of 60 miles an hour. I will not guarantee that such is the case; but admitting that soaring birds can move from place to place at a speed of 30 miles or more, it is quite possible that if their irregular course were measured in reference to the air, their speed would be something near 60 miles an hour. Under such circumstances the tilt of the wing would be very slight indeed, and the ratio of the resistance to the lift would probably be less than one-fortieth, even though the weight of the bird exceeded 2 lbs. per square foot. If we assume the bird travels at this speed, and any wind be blowing which changes velocity by 10 miles every 10 seconds, also assume, as in the previous case, that the acceleration and retardation of the bird is 1 ft. per second, and that the average relative difference of wind amounts to 3 miles per hour as in the previous case, then the sustaining value of that wind becomes not less than $\sqrt{63^2 - 60^2}$, or 19.2 miles an hour.

Roughly speaking, this might account for 30 per cent. of the power required in flight; the balance, judging from the peculiar buzzing noise made by soaring birds in flight, is possibly furnished by a very rapid but almost invisible motion of the pen feathers of the wing. A. M. Herring.

"PROGRESS IN FLYING MACHINES," BY OCTAVE CHANUTE.

Published by "The American Engineer and Railroad Journal," No. 47 Cedar Street, New York.

(From *L'Aeronaute.*)

During the twenty-seven years that I have had charge of the editorial work of *L'Aeronaute* it has been my privilege to publish the description of many kinds of apparatus designed for work in aerostatics and aviation; I have published many scientific papers, written by authors among whom may be found the names of the most eminent scientists of our day, and certainly this has been a cause of great satisfaction to me.

I have had a certain desire for a long time—I would have liked to publish consecutive tables of all the works that have appeared during this long period of time. My old friend, Gabriel de la Landelle, has often tormented me with this refrain:

"My dear friend, you ought to publish every ten years an indexed table of all your articles, in order to render them easy of access to those in search of information."

I have always replied that I had no time to do such a piece of work as that; and if some young man would undertake it I would give him my heartiest encouragement.

La Landelle would say: "Ah! if I were only young I would undertake this task."

But La Landelle is dead, and nobody seemed desirous of undertaking such a burden, when I received a book which has in some ways taken the place of the work which I desired, at least in that portion of it which touches the apparatus of aviation.

Mr. Octave Chanute, President of the Congress of Civil Engineers, and of the Aerial Conference held in Chicago, has just published a book regarding the numerous attempts which have been made in the construction of apparatus for aviation.

Mr. Chanute had found in *L'Aeronaute* the greater portion of the documents which he publishes, where he has done better than merely make a catalogue of them, in that he has added his own personality and has done his work with the persistency of a convinced aviator and an engineer of the highest merit.

Unfortunately his work is written in English. I hope, nevertheless, that Mr. Chanute, who speaks and writes French, would be willing to make the translation of his work into our language, and do it himself. Mr. Chanute's book will be of the greatest advantage in the study of aviation, but it will be particularly useful to me.

I very often receive visits from inventors who declare that they have found the solution of the problem. Ninety-nine times out of one hundred the invention is public property; and sometimes when I tell this to the inventor he assumes a very lofty attitude in saying, "But how can you prove it to me, sir, that my idea has already been published?" In order to do this it would be necessary for me to make a search through the files of *L'Aeronaute.* I have not done this for want of time; and the inventor has gone away convinced that I have been merely desirous of preventing progressive men from bringing out their ideas and of discouraging them.

But the thing will be more simple now. I have only to open Mr. Chanute's book to point out the description and the design of the apparatus to the *soi-disant* promoter. It is true that this method may not always succeed.

Three years ago I received a visit from a gentleman who announced that he was going to abolish taxes, suppress war,

etc. (this is the usual formula), by means of a flying machine which he had invented.

I asked him if he had any intention of deriving the usual benefits of this invention by taking out a patent. He declared he would be an idiot if he did not derive some benefit from so marvellous an idea, and furthermore he had children, and that he was resolved to leave them an immense fortune.

I tried to make him understand that his invention was not patentable, for it had been described a long time previously in a number of *L'Aeronaut*, dated fifteen years back.

He cried : " What ! because some clown has caused an article to appear in your paper which is more or less like mine, cannot I, a citizen, an influential elector, have an idea patented which would give power and glory to my country and fortune to myself ? But in such a case as that your paper is a danger to all the world and ought to be burned in the public square at the hands of the executioner. Furthermore, I am resolved not to follow your advice. I am going direct to my patent agents, who have promised to get my invention patented. When that is accomplished, I will go to the Government, and from them I will demand three million francs and the Cross of the Legion of Honor. If the Government will not accept this proposition I will exploit my patent myself."

And he went away and never came back. But I learned afterward that he spent all his property in patents and fruitless attempts, and that he was in deep dejection.

Another instance less sad than that occurred more recently. We know that Gabriel de la Landelle, in his treatise on aviation (" Traité d'Aviation ") published the design of a projected aeroplane raised in the air by vertical screws and propelled by horizontal screws. A short time afterward a certain journal attributed the idea of a similar apparatus to an inventor of whom it had a great deal to say. A few days afterward another journal published an indignant letter from a man who claimed that he had flown, and that the invention was his.

Mr. Chanute's book will do away with cases where money is wasted in fruitless experiments, and especially in patents and taxes, which the State imposes upon people who think they have discovered something. It is very certain, if we could have all the money that has been spent in patents for aeronautical devices, we would have enough to solve the problem.

Mr. Chanute begins with the history of mechanical birds, then he touches helicopters, and finally aeroplanes. All of his descriptions are made complete by engravings, taken for the most part from *L'Aeronaute.*

This work is an instrument for important study ; it is condensed into 300 pages, and is edited by a man whose competency nobody can doubt. Nevertheless, Mr. Chanute, sharing in the general opinion prevailing in England and America, shows his preference for the aeroplanes. M. du Hauvell a long time ago demonstrated this idea mathematically ; but M. Veyrin, by his recent experiments, has given an impetus to the theory of aeroplanes.

We know, since Launoy and Bienvenu (1792, Académie des Sciences) that an apparatus can be raised vertically into the air by means of screws expending a force of 6 kilogrametres per kilogram.

We know that screws on a horizontal shaft can propel an apparatus horizontally by expending a force increasing as the cube of velocity. As I have already said, Gabrielle de la Laudelle desired to use horizontal and vertical screws at the same time ; but a casual examination will show that vertical screws, by becoming useless after leaving the earth, would be extremely detrimental in presenting a very large surface to resist advancement. The desire has therefore been to replace the ascensional screws by a large suspending plane.

Recent calculations demonstrate that the resistance to the advancement of these planes by an enormous surface would be almost as great as that produced by elongated balloons.

M. Renoir proposed in 1872 to use oblique screws (*L'Aeronaute*, January, 1873, page 23), but never put his idea into execution. Then M. Veyrin has shown practically that by inclining a vertical screw and by a system of displacing the centre of gravity we can obtain with this oblique screw a high horizontal velocity. Then what good comes from embarrassing one's self with the immense surfaces of aeroplanes, when by simply changing the construction of the screw we can attain the same results ?

I do not think that inclined screws (Vaillent) are worth as much as flapping wings. I do not say more than that M. Veyrin has demonstrated that his apparatus has the same chance of success with actual motors (he does not think so himself) ; but it seems to me that he has demonstrated that he ought not to trouble himself any more with aeroplanes having screws on a vertical shaft.

Abel Hureau de Villeneuve.

RECENT AERONAUTICAL PUBLICATIONS.

Proceedings of the International Conference on Aerial Navigation, held in Chicago, August 1, 2, 3 and 4, 1893. The American Engineer and Railroad Journal, 47 Cedar Street, New York. 429 pp., $5\frac{3}{4} \times 9$ in. $2.50.

This volume contains the reports of the proceedings of this Conference, which were first published in Aeronautics, and includes the following papers, with discussions of many of them :

Preliminary Address of the World's Congress Committee on an International Conference on Aerial Navigation.

Opening Address. By O. Chanute, C.E.

The Problem of Aerial Navigation. By C. W. Hastings, Civil Engineer, deceased.

The Internal Work of the Wind. By S. P. Langley, Secretary of the Smithsonian Institute, Washington, D. C.

Anemometry. By S. P. Ferguson, Blue Hill Meteorological Observatory.

The Air Propeller. By H. C. Vogt, Naval Experimenter, Copenhagen, Denmark.

The Elastic Fluid Turbine as a Motor for Aeronautical Use. By J. H Dow, Mechanical Engineer, Cleveland, O.

Notes on Materials of Aeronautic Engineering. By Professor R. H. Thurston, Director of Sibley College, Ithaca, N. Y.

Flying Devices. By G. Crosland Taylor, F.R.G.S. and A.I.E.E., Helsby, England.

Atmospheric Gusts and their Relation to Flight. By Professor A. F. Zahm, Professor Nôtre Dame University, Nôtre Dame, Ind.

Sailing Flight. From Observations made at Constantine, Algeria. By J. Bretonnière, Engineer and Observer, Constantine, Algeria.

Theory of Sailing. By W. Kress, Vienna, Austria.

Soaring Flight. By E. C. Huffaker, C.E., Bristol, Tenn.

Theory of Soaring Flight. By Ch. de Louvrie, Engineer, Combebizon, France.

The Mechanics of Flight and " Aspiration." By A. M. Wellington, Member Am. Soc. C. E.

On the Action of Birds' Wings in Flight. By B. Baden Powell, Lieutenant Scot's Guards, England.

Notes on the Designing of Flying Machines. By J. D. Fullerton, Major Royal Engineers, England.

Aeroplanes and Flying Machines. By W. Kress, Vienna, Austria.

Note on an Elastic Screw. By W. Kress, Vienna, Austria.

The Advantage of Beating Wings. By Ch. de Louvrie, Engineer, Combebizon, France.

Stability of Aeroplanes and Flying Machines. By Professor A. F. Zahm, Nôtre Dame University, Nôtre Dame, Ind.

Flying Machines, Motors and Cellular Kites. By Lawrence Hargrave, Experimenter, Sydney, N. S. W.

Suggestions and Experiments for the Construction of Aerial Machines. By F. H. Wenham, Engineer, Goldsworth, England.

Methods of Experimentation. By A. P. Barnett, Experimenter, Kansas City, Mo.

Learning How to Fly. By C. E. Duryea, Mechanical Engineer, Peoria, Ill.

A Programme for Safe Experiments. By L. P. Mouillard, Observer, Cairo, Egypt.

Experiments with Hexagon and Tailless Kites. By W. A. Eddy, Experimenter, Bayonne, N. J.

Some Experiments with Kites. By J. Woodbridge Davis, New York City.

Manufacturing Hydrogen Gas Balloons. By C. E. Myers, Aeronautical Engineer, Frankfort, N. Y.

Natural Gas Balloon Ascensions. By C. E. Myers, Aeronautical Engineer, Frankfort, N. Y.

Flotation *v.* Aviation. By Professor De Volson Wood, Stevens' Institute, Hoboken, N. J.

Manœuvring of Balloons. By C. E. Myers, Aeronautical Engineer, Frankfort, N. Y.

Systematic Investigation of Upper Air. By M. W. Harrington, Chief of Weather Bureau, Washington, D. C.

Observations from Balloons. By C. C. Coe, Aeronaut, Ridge Mills, N. Y.

Balloon Meteorology. By C. E. Meyers, Aeronautical Engineer, Frankfort, N. Y.

Scientific Results Gained by Balloons. By H. A. Hazen, Weather Bureau, Washington, D. C.

Explorations of the Upper Atmosphere. By N. de Fonvielle.

Ten Miles above the Earth. Discussion by H. A. Hazen.

Appendix containing discussions of some of the papers.

The above volume is now ready for delivery.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

Formerly the RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

The American Railroad Journal, founded in 1832, was consolidated with Van Nostrand's Engineering Magazine, 1887, forming the Railroad and Engineering Journal, the name of which was changed to the American Engineer and Railroad Journal, January, 1893.

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NEW YORK, MARCH, 1895.

EDITORIAL NOTES.

ATTENTION is called to the paper on the Deterioration of Locomotive Boilers through the Effects of Expansion, the publication of which is commenced in another column. It is written by Herr Lentz, the designer of the stayless boiler, and contains a great deal of valuable information regarding the strains to which steam-boilers are exposed, which has been ascertained by his own and the experiments of others.

THE action of the railroads centring in Chicago relative to the modification of the Rules of Interchange has had the apparent effect of causing the General Committee of the Master Car-Builders' Association to send out a circular asking for the opinions of the members as to the advisability of so modifying the rules that owners are liable for all ordinary repairs, and that inspection shall be for safety rather than pecuniary protection. The rules of interchange, simple in their first formulation, have grown by yearly accretions and the decisions of the Arbitration Committee, until they are now such a ponderous mass that the layman makes no pretence of understanding their conditions. It would seem that they have become so heavy that they are about to go to pieces by their own weight.

WE recently had occasion to note that the immunity from serious damage shown by the Chinese armored battleships in the Yaloo fight was to be used before the Naval Committee as an argument for the construction of additional armored battleships for the United States. It seems that this argument has had a further strengthening by the action of the Japanese, who have taken advantage of the experience gained in this war, and have ordered two battleships that are to be built on the Thames. They are to have a displacement of 12,250 tons, a length of 370 ft., a breadth of 73 ft. The armor is to extend for 226 ft., and is to be from 10 in. to 18 in. in thickness. The H.P. is to be 4,000. Two 12-in. breech-loading rifles will be behind 14 in. of armor. Such is one of the practical naval lessons of the war, and the first steps of Japan toward the assumption of a place as a maritime power, her present navy consisting of cruisers and torpedo-boats.

POSSIBLE SOURCES OF FUEL ECONOMY IN LOCOMOTIVES.

LAST month we published some comments on a paper read before the Western Railway Club by Mr. William Forsyth, on Locomotive Fuel, which contained a special inquiry into "the heat values of Western coal." In this paper he made the statement that the fuel used in 1893 on the road with which he is connected (the Chicago, Burlington & Quincy) cost $1,291,108. In his paper he says, further, that "in 1885 the Chicago, Burlington & Quincy Railroad Company had an exhaustive series of tests made of all the Illinois coals that were then used." The results of these tests were given in a table in which "Streator" coal was taken as the standard, the cost of which at the mine was $1.30 per ton. He then gives the comparative evaporative value of 17 different kinds of Illinois coal, the cost of each at the mine, and the actual value compared with Streator coal. Thus the comparative evaporative value of Streator coal being assumed to be 1, that of the second on the list was only .724, so that if Streator was worth $1.30 per ton, then relatively the second sample was worth only $1.05, whereas it cost $1.45, which means that if the company bought that kind of coal they would be paying 38.1 per cent. more for it than its actual worth. The third sample was shown to have a relative value of .793, and was therefore worth only 99 cents and cost $1.25, so that its price would be more than 26 per cent. greater than its value.

The average cost of the 16 inferior qualities of coal tested was $1.34, and its average comparative value was only .857 and its actual value $1.15, so that if the orders of the company had been distributed equally among those 16 kinds of coal instead of buying Streator, the loss would have been 19 cents per ton, or over 14 per cent.

The importance to a railroad company of knowing the relative *value* of the coal it buys is obvious. In the case before us, if the Chicago, Burlington & Quincy Railroad Company had bought none but the second kind of coal instead of Streator it would have lost $491,912.14; and if it had been supplied with the third kind the loss would have been $339,561.40; and if it had distributed its orders equally among all the kinds of coal used, the loss would have been $180,755.12. The additional expense of handling the greater quantity of coal required would doubtless have run the excess of cost up to $450,000, $350,000, or $200,000 in these hypothetical instances.

The purpose of Mr. Forsyth's paper and the object of making these calculations was to show the importance to a railroad company of knowing what the *actual* value is of the fuel which it buys. This should be determined by some adequate tests, and not be a matter of mere surmise. It is hardly necessary to add that ordinarily the value of the fuel which is bought and used by railroad companies is not ascertained by any investigations or tests worthy of credence. Too often, too, like the osculatory exercise, the purchase of coal goes by favor and not by merit alone. Some director or director's friend is interested in a coal mine, and his influence is sufficient to secure the orders for fuel, whether it is the best or not, and the superintendent of machinery is made to understand that tests of it would be distasteful to those who are higher in authority than he is, and so the company goes on and uses inferior fuel for years at a loss to its stockholders, but with a profit to the owners of the coal mine. The points which it is intended to em-

phasize here are, first, that comparatively few companies ever make any comparative tests of fuel which are reliable ; and, second, that it is of very great importance from an economical point of view that they should, and that the probabilities are that on most roads a considerable saving could be made if the coal used was subjected to rigid tests to ascertain its actual value. In these hard times it would seem as though every railroad company would want to know with absolute certainty what the real value is of the fuel which it buys.

There is no source of economy in locomotives which has probably received more attention than that of the valve gear and the distribution of steam in the cylinders. Notwithstanding that so much thought, ingenuity and experiment has been devoted to it, it is still true that in nearly all locomotives, especially those which run at a high speed, there is a very considerable loss of economy, partly from an imperfect admission of steam to the cylinders and also from back pressure resulting from imperfect valve gearing and contracted exhaust nozzles. These difficulties have seemed to be almost inseparable from the use of the link motion ; and some months ago* the query was suggested in these columns whether a return to some of the old forms of valve gear, in which separate cut-off valves were used, or some modification thereof, might not be attended with advantage. A late number of *Engineering* (February 1) contains engravings of a heavy express locomotive rebuilt for the Northeastern Railway of England, with a single pair of driving-wheels 7 ft. 7¼ in. diameter, showing the valve gear and indicator diagrams taken therefrom. These are calculated to lead to the inference that a separate cut-off valve may not be needed in order to get a practically perfect distribution of steam in locomotive cylinders even at speeds as high as 60 miles an hour. We reproduce herewith fig. 1, which shows a sectional view of the cylinders and steam-chest of this engine.

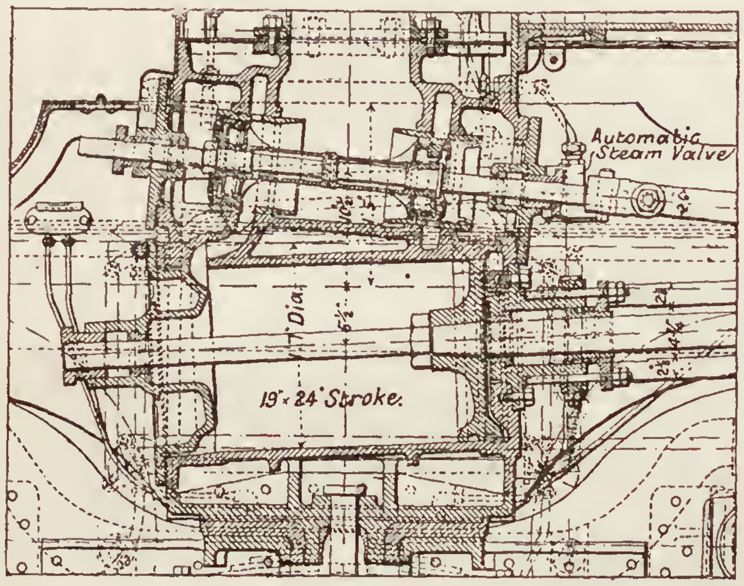


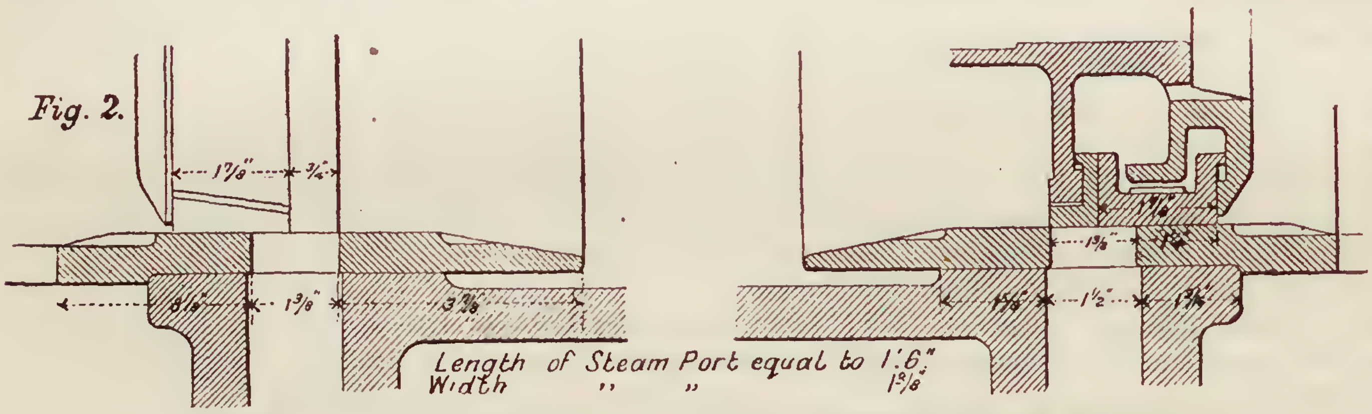
Fig. 1.

SECTION OF PISTON AND VALVE, EXPRESS LOCOMOTIVE NORTHEASTERN RAILWAY.

The cylinders are 19 in. diameter, and are inside the frames and connected to a cranked axle of the usual English type. Two pistons 8 in. in diameter form the valves. An enlarged section of the steam ports is shown in fig. 2, the packing of one of the valves being also shown in section in the right-hand side. The lap, it will be seen, is 1¼ in. The throw of the eccentrics is 5¾ in., but the eccentric-rods are connected to the ends of the links so that the full throw of the eccentrics is not communicated to the valves. A single exhaust nozzle is used, which on one of the engravings is marked 4¾ in. and on another 5⅛ in diameter. On a third view it is represented as of smaller diameter than on either of the others, but the dimension is not given. We are not able to reconcile these differences unless it be that in some way the size of the nozzle is adjustable in a manner not clearly shown in the engravings. Figs. 3 to 11 represent indicator diagrams taken with this gear. Our readers will, we think, agree with us in thinking that these diagrams are very remarkable. Probably no link-motion valve gear has ever shown such a perfect distribution of steam. The corners at the points of admission and cut off, it will be seen, are as sharp as though drawn by a skilful draftsman, and in some of the diagrams the expansion curve is slightly better than a theoretical curve would be. It would be interesting to know the particulars more fully and the conditions under which these diagrams were made. There is nothing remarkable about the link or its connections. Is the perfection of these diagrams due to some peculiarity of the piston valves or of the exhaust nozzles? It will probably be safe to say that these diagrams, if compared with the average of steam distribution on ordinary locomotives, would represent an economy of at least 10 per cent. in the consumption of steam. If this is due simply to the design of the valves or their gear we have an economy which is not dependent upon any unattainable perfection of skill or discipline in the men, but which would be inherent in the mechanism of the gear. It may be added that it is stated by the *Engineer* that "this type of engine was originally designed by Mr. Thomas W. Worsdell, when Locomotive Superintendent of the line, it being then fitted with compound cylinders ; but in the course of rebuilding, as the cylinders required renewing, the engines have been fitted by Mr. Thomas Worsdell, the present Locomotive Superintendent, with non-compound cylinders provided with piston valves, *and with very satisfactory results*." (The italics are ours.) It cannot be assumed that this is conclusive evidence against compound engines, because we don't know how good or how bad this particular compound engine was which was altered. To replace a bad compound engine with a good simple one may be a gain, while such a change would not be desirable if a compound locomotive was of the best type. Of the change, however, by parties who at one time had sufficient confidence in the compound system to give it a very thorough trial, it may be observed—as some one did when he found a live trout in the milk—that "it was strong circumstantial evidence." What is especially pointed out here is that if a perfection of valve gear equal to that which is shown by the indicator diagrams which Mr. Worsdell has made is attainable, it would represent a considerable economy, which it may be assumed would be equal to 10 per cent.

Last month we reprinted a table (page 60) showing the per-

Fig. 2.

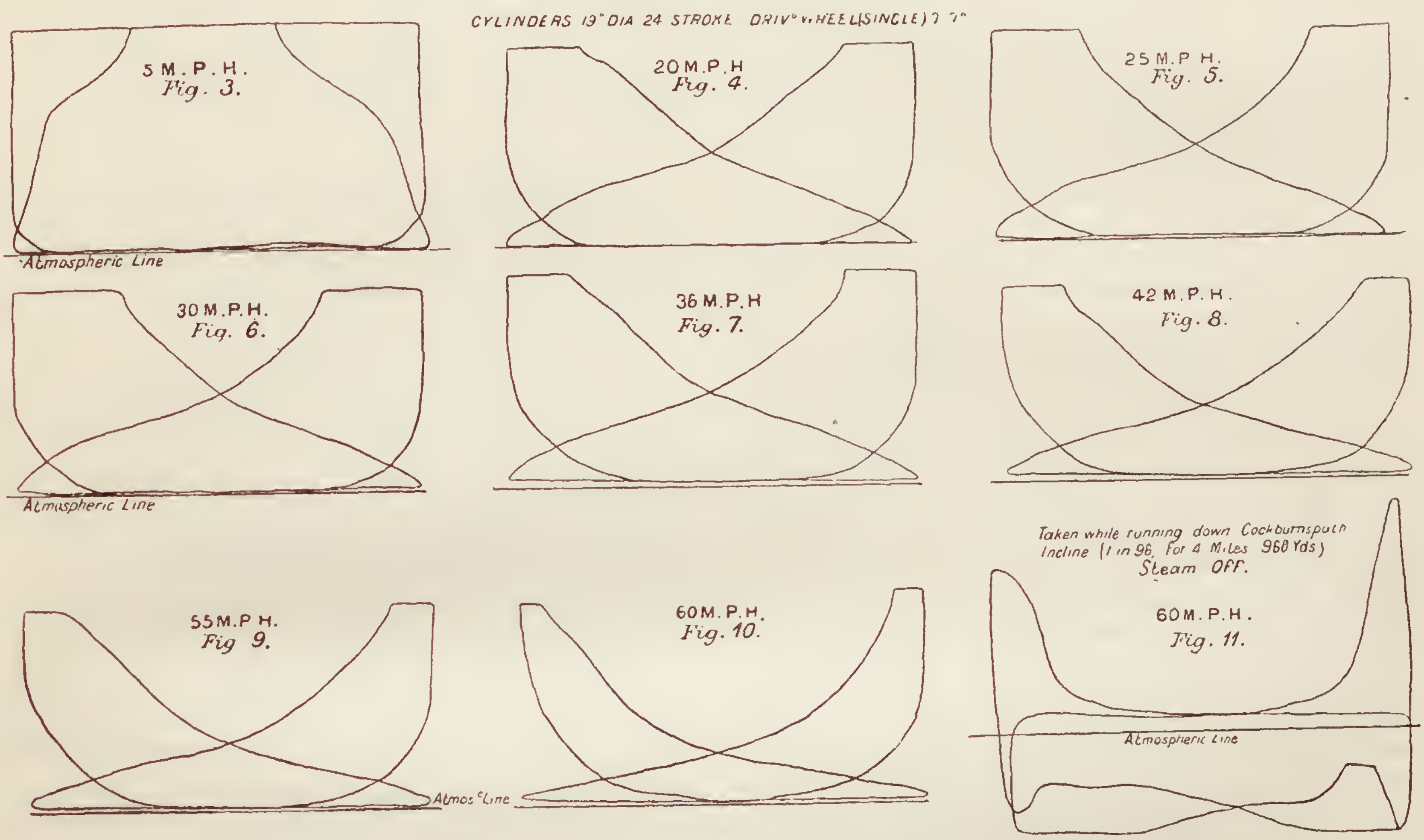


VALVE ARRANGEMENT, EXPRESS LOCOMOTIVE NORTHEASTERN RAILWAY.

* April last.

centage of saving of fuel by heating feed water. That table showed that with feed water having an initial temperature of 60° there would be a saving of 14 per cent. if it was heated to 220° with steam at 60 lbs. pressure. It would be about 13 per cent. for steam of 175 lbs. Another table published with this number and compiled by another manufacturer of feed-water heaters agrees very closely with the one we gave last month. That such a theoretical saving is possible by heating feed water can be demonstrated, and has been proved practically a great many times. But feed-water heaters have been tried on locomotives a hundred or more times and have always been abandoned, notwithstanding their economy. The reason seems to be this: the urgent and obvious end to be attained on a railroad is to get the traffic—that is, the cars to be hauled—over the road. Sometimes this must be done with insufficient equipment in the motive power department. At such times if one or more locomotives are disabled the delay, inconvenience and annoyance of having traffic congested is at once apparent to all who are responsible for the working of the road, and it then fails in its primary purpose, end and aim. Consequently there is a storm of indignation at once. If the cause is feed-water heaters, the argument is apt to be expressed profanely, and the locomotive superintendent is or may be ordered to take off these —— heaters. Now, supposing that there is an increased consumption of coal as a consequence of their removal. Probably few people will ever know it. The trains will or may be going over the road regularly day after day, and unless some one with an aptitude for statistics should analyze the accounts of fuel consumption, or if no such accounts are kept, no one will know whether 13 per cent. more or less of coal is burned. The locomotive superintendent and his subordinates might be happy under these circumstances, and the superintendent and manager be content in their ignorance, whereas if an apparatus which was saving a considerable percentage of fuel should delay a few trains, probably the lot of the locomotive men would not be a happy one. Now the question arises whether it is not possible to devise a feed-water heater which would not be liable to get out of order, or which, if it did, would not delay the engine to which it was attached, and the maintenance of which would not be so costly as to eat up all or most of the theoretical saving? Feed-water heaters are very commonly used on stationary engines, and are found to be economical and reliable in that service. It is hard to see why there should be any inseparable obstacle in the way of their use on locomotives.

Last month (page 89) an account was also published of some experiments made at Durlach (which, it was erroneously stated, was in Switzerland; it in reality is in Bavaria) with Schmidt's superheated steam boiler and engine. Some remarkable results are reported with this. There can be no doubt of the economy resulting from the use of superheated steam, and with improvements which have been made of late years in lubricants which can now be obtained to withstand higher temperatures than animal oils will, a degree of superheating seems to be practicable which a decade or more ago always resulted in failure. An economy of about 20 per cent. seemed to be indicated by the experiments referred to. The great saving due to the use of superheated steam has long been known; the difficulties have always been in the practice and not in the theory. Our correspondent wrote that "this subject is being steadily investigated over here." There is good reason for expecting important advantages from this source.



INDICATOR DIAGRAMS FROM EXPRESS LOCOMOTIVE NORTHEASTERN RAILWAY. DIAGRAMS TAKEN WHILE WORKING AN EXPRESS TRAIN BETWEEN NEWCASTLE AND EDINBURGH.

Load, 14 Coaches, Engine 1519 (Piston Valves), October 20, 1894.

As we are not aiming at strict accuracy, but only making a probable hypothesis, it may be stated that an economy of about 14 per cent. seems to be possible by simply ascertaining the relative quality of coal bought. In other words, the experience on the Chicago, Burlington & Quincy Railroad indicates that the best coal on that line is 14 per cent. better than the average; and if a railroad company or any other purchaser has no means of knowing which is the best, they are likely to get an average.

Second, the difference resulting from the use of a perfect

valve gear compared with one which is imperfect may and probably would be as much as 10 per cent or possibly more in the fuel consumption.

Third, a saving of 14 per cent. seems to be possible from the use of a feed-water heater.

Fourth, a saving of 20 per cent. appears to be within reach by using superheated steam.

Let it be assumed that the fuel consumption on a road is represented by $1,000,000 ; if 14 per cent. was saved by simply testing it and learning which was the best quality to buy, the $1,000,000 would be reduced to $860,000. If, now, we save 10 per cent. by an improved valve gear, the million is reduced to $774,000. If feed-water heaters should save 14 per cent., then the cost of fuel would be lowered to $665,640 ; and if superheated steam should fulfil its promise of 20 per cent. saving, the fuel account would be brought down to $532,512. Now, of course, there will be a debit side to this account to which it would be impossible perhaps now to assign any even approximately correct value, and the attempt will not be made. The only purpose of this article is to show that an economy nearly or quite equal to half the cost of the fuel is possible. That this is not a mere visionary theory was shown in an article in these pages (December, 1894, page 532) in which statistics were given which proved that "in the best performance of locomotives the fuel consumption is *only half* that of the average performance on well-managed railroads."

Of course it is true that the cost of such economies may be greater than the saving, and what may also be a serious obstacle is that the appliances required to secure some of these savings might interfere seriously with the traffic of a railroad. But this difficulty may not be an insurmountable one. It may be possible, for example, to devise a feed-water heater and a steam superheater which would not interfere seriously with the regular working of a locomotive. An economy of nearly or quite 50 per cent. would permit of a considerable number of debit charges for extra expenses. In these days, when intelligence and scientific methods are applied to almost all industries, it would seem as though it would be worth while for some railroad company or perhaps a number to employ some thoroughly competent expert to proceed in a cautious and tentative way to see what may be done in this direction. The person to succeed in this line of investigation must, however, be something more than a practical mechanic or a college professor or graduate of a technical school. It is true, he ought to be a practical mechanic and have the resources of a college professor available, and be an ingenious inventor with a head which would always be as level as the surface of a quiescent pond. Wanted, such a person, and one or more railroad companies with sufficient intelligence, liberality and enterprise to employ him to make investigations on the lines indicated.

NEW PUBLICATIONS.

The Elementary Principles of Mechanics. Vol. I. Kinematics. By A. J. Du Bois. New York: John Wiley & Sons. 225 pp.

Mechanics is a typical science. Its fundamental principles conform so perfectly with nature that the results derived therefrom are considered as interpretations of nature. The mathematician includes in his formulas the whole planetary system, and uses his analysis in the discussion of phenomenon so remote as to require decades of years for the physical phenomenon to reach the earth.

The foundation for this grand science was laid by Galileo nearly 300 years ago in his discovery of the simplest of the laws of motion, and Descartes added an impetus to the ideas thus promulgated. Newton less than 150 years ago established his law of gravitation, and La Grange about a century ago published his incomparable work, "Le Mécanique Analytique," in which he proposed to establish general formulas, the simple development of which would enable one to solve special problems. In his day this subject was studied by very few, and no attempt was made to teach it in general courses of instruction, and the style in which La Grange presented the subject was adapted only to mature and strong-minded students. L'École Polytechnique, however, which contained in its faculty La Place, La Grange, Poisson and others, taught it in all its severity. It sometimes requires the labors of a variety of minds and years of effort to modify methods of analysis and processes of reasoning so as to make a subject available for the average student. This fact makes excusable the production of many books upon a science, although some of them may fall short of the ideal standard of an expert.

There has been a tendency of late years among writers to treat mechanics under three heads: Kinematics, Statics and Kinetics. There is an advantage in this, since it enables the writer to keep more prominently in view one particular thought, and to develop that more thoroughly ; but there is a disadvantage by separating the solution of higher problems into parts, one part being in one place and the remaining part in another, the different places sometimes being in different books. To a student who acquires a thorough knowledge of the subject, the advantage of the former probably greatly outweighs the disadvantage of the latter.

The work before us treats only of kinematics, and the subject is very fully developed. Several modern terms are properly introduced, as "scalar," "vector," "hodograph." A simple glance at its pages shows one how much there is in dynamics that is included in mere motion and the relations of motion, and would seem to leave a small field for kinetics proper.

It is noticed that the author makes a proper distinction between speed and velocity without making a distinction in the symbols representing them, the letter v being used to indicate both ; while the rate of change of speed is indicated by the letter a, and the rate of change of velocity by the letter f. Memory is aided by association ; and when it can conveniently be done should be used in science. The letter v, the initial of velocity, is in very general use ; and a, the initial of acceleration, may be used with good effect in a similar way.

Although in kinematics motions are to be discussed without regard to the agents producing them, the author has, in some cases, introduced the term "force," as on page 99, where "attractive force" and "repulsive force" are used to explain negative and positive accelerations. It also appears in other places.

Some solutions are given both with the use of the calculus and without. Some may prefer to study a subject in this way ; but as time is short and art is long, we fancy that most students who have not a knowledge of the calculus will prefer a book in which it is not thrust before their eyes ; and those who are able to use it will not care to have other methods in their way. It appears, from a remark of the author, that it was intended to aid the student in choosing an abridged course by means of "larger type ;" but this feature, if indeed it exists, is not sufficiently apparent. The appearance of the typography is not as pleasing to our eye as that of many other works issued by this well-known firm.

The examples are numerous and varied, and well designed to illustrate and enforce the theories . On the whole, it is a valuable addition to the literature of the subject.

"Science." This paper, after a brief suspension, also comes in a new form, the pages of which are a little larger than the ordinary magazines. It will hereafter be conducted by the following editorial committee: S. Newcomb, Mathematics ; R. S. Woodward, Mechanics ; E. C. Pickering, Astronomy ; T. C. Mendenhall, Physics ; R. H. Thurston, Engineering ; Ira Remsen, Chemistry ; Joseph Le Conte, Geology ; W. M. Davis, Physiography ; O. C. Marsh, Paleontology ; W. K. Brooks, Invertebrate Zoölogy ; C. Hart Merriam, Vertebrate Zoölogy ; N. L. Britton, Botany ; Henry F. Osborn, General Biology ; H P. Bowditch, Physiology ; J. S. Billings, Hygiene ; J. McKeen Cattell, Psychology ; Daniel G. Brinton, J. W. Powell, Anthropology.

It is published at 41 East Forty-ninth Street, New York.

Elasticitaet und Festigkeit (Elasticity and Strength of Materials). By C. Bach, Professor of Mechanical Engineering, Technical High School, Stuttgart, Germany, with Illustrations and 15 Photogravures. Second Edition. Berlin: Julius Springer, 1894. 432 pp., 6 × 9 in.

The typographical work in this book and the paper on which it is printed are so much superior to the ordinary books of similar nature printed in this country, that they are worthy of notice. The photogravures are illustrations of test specimens, and aside from being interesting and instructive, are artistic in execution.

The general features of the book, as well as its value, are pretty accurately set forth in the preface.

The work is largely mathematical, but it is written with unusual clearness, and each subject is practically complete within itself. It is divided into seven parts, these being subdivided into chapters and paragraphs. The paragraph is really the unit, and, as the number of each is printed at the head of the page on which it appears, it becomes very easy to look up a reference when one is made to another paragraph.

The first part treats of straight beams subjected to simple cases of tension, compression, bending and buckling. In this part the author substitutes for the commonly used modulus of elasticity a "coefficient of elasticity," this coefficient being simply the reciprocal of the well-known modulus. He defends this change very justly as being in the direction of reason, being more readily used from the fact that it is applied directly rather than in a reciprocal manner, and that it is a fact which needs no assumption of impossible conditions; later on he introduces also a coefficient of shear rather than a modulus of shear.

The mathematical determinations are supplemented by the results of original experiments made by the author, and also by results from other sources. The change of form and nature of fractures is clearly illustrated in the plates, and this experimental feature is common to most of the articles; it is one of the most interesting parts of the work.

The author shows that the coefficient of elasticity for some materials, commonly considered constant within certain limits of strain, is not so in cast iron, a material so commonly used in the construction of machinery. The law of variation for this is given graphically.

The influence of different shapes of test pieces on the results is clearly shown, especially in relation to cast iron.

The second part treats of torsion and shear in straight beams. Torsion of beams of other section than circular are treated at considerable length. The subject is elaborated by experiments and well illustrated by photogravures showing nature of changes.

The third part treats of work performed in the elastic changes under the conditions treated in the previous parts

The fourth part treats of the effect of combined stresses in straight beams, such as tension, shear, etc. This part is particularly instructive in showing the fallacies which often exist in proportioning parts for one kind of strain only when another is present and is really the more important.

The fifth part treats of the effect of stresses in beams which are not originally straight. The hook is specially discussed.

The sixth part treats of the strains in cylindrical and spherical vessels subjected to liquid pressures from inside and out.

The seventh part treats of flat plates of various shapes subjected to pressure, as, for instance, manhole covers, etc.

The book is of value to the student from its clear mathematical determinations, some of which are evidently new in method at least. It is also of value to the practical man who does not wish to spend a great deal of time in following the author through his demonstrations from the experimental data given and from the fact that at the end of each subject treated the result arrived at is given in a very concise manner in double-leaded type.

Proceedings of the International Electrical Congress, held in Chicago, August 21–25, 1893. Published by the American Institute of Electrical Engineers, 26 Cortlandt Street, New York. 488 pp., 6 × 9¼ in. $3.

The proceedings of this notable gathering of electricians will be warmly welcomed by electrical engineers generally. It covers so broad a field that a review in the space that is available is impossible. We must therefore content ourselves with simply a list of papers and discussions, which is as follows:

Opening of Congress; Proceedings of the Chamber of Delegates; Proceedings of Section A; On the Analytical Treatment of Alternating Currents, by Professor A. Macfarlane; Complex Quantities and their Use in Electrical Engineering, by Charles Proteus Steinmetz; General Discussion of the Current Flow in Two Mutually Related Circuits Containing Capacity, by Frederick Bedell, Ph.D., and Albert C. Crehore, Ph.D.; Explanation of the Ferranti Phenomenon, by Dr. J. Sahulka; Measurements of the Energy of Polyphase Currents, by A. Blondel; The Extended Use of the Name Resistance in Alternating Current Problems, by Professor W. E. Ayrton; Proceedings of Section B; Signalling through Space by Means of Electric Magnetic Vibrations; Ocean Telephony, by Silvanus P. Thompson, D.Sc., F.R.S.; Materials for Wire Standards or Electrical Resistance, by Dr. Stephen Lindeck; Some Measurements of the Temperature Variation in the Electrical Resistance of a Sample of Copper; Note on Photometric Measurement, by Professor B. F. Thomas; A Pair of Electrostatic Voltmetres; On a Method of Governing an Electric Motor for Chronographic Purposes; Iron for Transformers, by Professor J. A. Ewing, F.R.S.; London Electrical Engineering Laboratories, by Professor Andrew Jamieson, Member Inst. C. E., F.R.S.S.E., etc.; Transformer Diagrams Experimentally Determined, by Dr. Frederick Bedell; On an Improved Form of Instrument for the Measurements of Magnetic Reluctance, by A. E. Kennelly; Variation of P. D. of the Electric Arc with Current, Size of Carbons and Distance Apart, by Professor W. E. Ayrton, F.R S.; Light and Heat of the Electric Arc, by M. J. Violle; On the Maximum Efficiency or Arc Lamps with Constant Watts, by Professor H. S. Carhart; The Periodic Variation of Candle Power in Alternating Arc Lights, by Benjamin F. Thomas, Ph.D.; New Researches on the Alternating Current Arc, by A. Blondel; On the Continuous Current Arc and Its Employment as a Photometric Standard, by A. Blondel; On the Source and Effects of Harmonics in Alternating Circuits, by H. A. Rowland; Proceedings of Section C; Rotary Mercurial Air Pumps, by Dr. F. Schulze Berge; Underground Wires for Electric Lighting and Power Distribution, by Professor Dugald C. Jackson; Various Uses of the Electrostatic Voltmetre, by Dr. J. Sahulka; A New Incandescent Arc Light, by Louis B. Marks; Direct Current Dynamos of very High Potential, by Professor Francis B. Crocker; Multiphase Motors and Power Transmission, by Dr. Louis Duncan; Exhibit of Tesla Polyphase System at the World's Fair, by C. F. Scott; Discussion on Power Transmission, by Dr. L. Bell, Mr. Stillwell, Professor S. B. Thompson, Professor Forbes and Mr. C. P. Steinmetz; A Novel Method of Transforming Alternating into Continuous Currents, by Dr. Charles Pollak; Discussion on Power Transmission, Continued, by Professor Forbes, Professor H. A. Rowland, Professor D. C. Jackson, Dr. L. Bell, Mr. Charles S. Bradley, Mr. Charles P. Steinmetz, Dr. Keith, Mr. Lemp, Mr. F. C. Hasson, and Dr. Louis Duncan; Note on the Variation of Capacity of Insulated Wires with Temperature, by Herman S. Hering; The Tesla Mechanical and Electrical Oscillators; International Electrical Congress Banquet; Final General Meeting.

Practice and Theory of the Injector. By Strickland L. Kneass, C.E. New York: John Wiley & Sons. 132 pp., 5¾ × 9 in. $1.50.

Usually a reviewer is assisted in learning an author's aim and scheme in writing his book by a preface. In the present instance, as there is no such introduction, the book itself and what it contains is the only source from which we can learn what the purpose of the author was in writing it.

The beginning is a chapter devoted to the early history of the injector from its invention in 1858 by Henri Jacques Giffard—to whom the honor is due—down to the present time, when, as the author tells us, more than 500,000 of these instruments or machines have been manufactured in this country. The next chapter is devoted to an account of the development of the principle of this wonderful appliance. Both of these chapters are admirably clear and satisfactory. They are followed by another short one which is very excellent in its purpose and execution. Its title is Definition of Terms—Description of the Important Parts of the Injector—Their Functions. This will be a great help in bringing about a uniform nomenclature. This purpose would have been still further promoted if a good engraving, as large as the page would admit, of a modern injector had been given, with names of the different parts either inscribed on them or indicated by reference letters, with a list of names appended.

The three following chapters are devoted respectively to The Delivery Tube, The Combining Tube, and the Steam Nozzle—Efficiency of Various Types—Effect of Different Shapes and Proportions. A theoretical investigation of the functions of each of these parts and accounts of experimental investigations are given. These chapters are followed by another on The Action of the Injector, which contains a full statement of its theory, to a considerable extent treated mathematically, the results of which are checked off by reference to experimental investigation.

Chapter VIII is on Application of the Injector—Foreign and American Practice—Description of Various Patterns of Injectors, in which the machines made by different makers are illustrated and described.

A word of criticism of the illustrations would seem to be in order here: none of them are very good, and some are very bad, notably those on pages 91 and 92. In these days of cheap engraving there is no excuse for an author or publisher giving his reader an ugly blotch like that on page 91. In describing complicated mechanism, the draftsman's art is as essential as

the skill and lucidity of an author. The writer of the book under review signs himself C. E. Now, it is a curious fact that most civil engineers seem to hold in contempt, or at least do not assign to the art of a draftsman, its real value, especially in the exposition of mechanical subjects. Let it be hoped that for a future edition the author will secure the co-operation of a good mechanical draftsman, who is well up in the æsthetics of his craft. Such assistance would add immensely to the pleasure with which the book may be read, and would greatly facilitate a comprehension of it. Vituperation of this kind, however, aimed at a minor fault, is perhaps partial injustice to an author who has given us an excellent book on a subject of which heretofore there has been no satisfactory exposition.

In the concluding chapter some excellent recommendations are given with reference to the size of injectors which should be used, and the methods of testing them. The handling and repair of injectors is treated in two short paragraphs at the end of the last chapter. Not sufficient attention or space seems to have been given to this branch of the subject, considering how many persons are interested in it. A comprehensive chapter on the *pathology* and another on the *therapeutics* of injectors would doubtless be gratefully received by those who have the care and must operate such instruments, which are often the cause of much anxiety and provocation. Mr. Kneass has given mechanical engineers the best book in existence on the subject on which he has written, and one which should be in the hands of and be studied by every person who is in any way concerned in the use of those invaluable appliances for feeding boilers. It is admirably clear in expounding the principles of these more or less mysterious machines. It is brought up to date in both its theory and practice, and with the exception of some of its engravings it may be commended to all readers who are interested in the subject which it was written to elucidate.

It is our duty to add another word of animadversion, to be administered this time to the publisher. We refer to the quality of the paper. It is made of wood pulp, which breaks on being folded. Before the rising generation have turned their toes upward into a permanently vertical position Mr. Kneass' excellent book—if the whole edition is printed on paper like that in the copy before us—will have passed into the dust of decay, and future generations will lose the light which it could shed on the "state of the art" and of the practice in the use of the appliances which he describes so well.

BOOKS RECEIVED.

The Memphis Bridge. A Report to George H. Nettleton, President of the Kansas City and Memphis Railway & Bridge Company. By George S. Morrison, Chief Engineer of the Memphis Bridge. New York : John Wiley & Sons.

TRADE CATALOGUES.

In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. The advantages of conforming to these sizes have been recognized, not only by railroad men, but outside of railroad circles, and many engineers make a practice of immediately consigning to the waste-basket all catalogues that do not come within a very narrow margin of these standard sizes. They are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

STANDARDS :

For postal-card circulars	$3\frac{3}{4}$ in. × $6\frac{1}{2}$ in.
Pamphlets and trade catalogues	$3\frac{1}{2}$ in. × 6 in.
	6 in. × 9 in.
	9 in. × 12 in.
Specifications and letter paper	$8\frac{1}{2}$ in. × $10\frac{3}{4}$ in.

Facts Worth Knowing about Pressure Regulators (Reducing Valves) and Pump Governors of Practical Value to all Steam Users. By the Foster Engineering Company, Newark, N. J. 40 pp., $4\frac{3}{4}$ × $6\frac{1}{4}$ in.

The purpose of this pamphlet is to describe and set forth the advantages of the Foster pressure regulator and its superiority over other devices for doing the same work. It gives very good wood-engravings of the device, with an explanation of its construction, a statement of the weak points of other regulators, and of the advantages of the one which the Foster company make. These are all excellent in their way, but they seem to be arranged in a wrong order. If the description given on pages 14 to 18 had been given first, and the commendation of the Foster regulator and the derogation of others afterward, they would all have been more easy of comprehension. The good points of this regulator are clearly set forth, however, and that is the main purpose of the publication. The Foster Company also make steam gauges and the McDowell inside safety chuck-valve for locomotives, the use of which, or of one equally good, should be compulsory on all locomotives.

The Norton Improved Ball-bearing Ratchet Screw Jacks. Manufactured by A. O. Norton, Boston, Mass. 20 pp., $5\frac{1}{4}$ × $7\frac{3}{4}$ in.

The ball-bearing feature of these jacks is described as follows by the manufacturers : "To the upper end of the screw is fastened a steel gear ; a hardened tool-steel plate encircles the hub and rests on the body of the said gear, on which are placed circular trains of hardened steel balls held in place by rings between the rows. In the top or head of the sliding sleeve is placed another hardened tool-steel plate with a hole in the centre, through which the end of the screw projects. When the jack is assembled the sleeve slides down over the screw and standard, the bearing plate in the head resting on the balls on the plate on the gear, so that the whole weight is carried by the balls between the steel plates, which act as a thrust bearing between the screw and head of the sleeve, reducing the friction and increasing the lifting power of the jack."

Various forms of this and also of non-ball-bearing jacks intended for different purposes are illustrated and described, and testimonials are given of their efficiency.

Catalogue and Price-List of Keuffel & Esser Company, Manufacturers and Importers of Drawing Materials and Surveying Instruments. 404 pp., $8\frac{3}{4}$ × $5\frac{1}{2}$ in.

Probably no better notice of this volume can be given than that which the Keuffel & Esser Company have had written, and which is contained in a letter received with it. In this they say :

"This edition is not a reprint from former ones, but has been rewritten and revised and enlarged by more than 100 pages. While we confine ourselves strictly to our line of business—drawing materials and surveying instruments—we have endeavored to omit nothing in this line which is good and reliable, and our catalogue therefore represents the latest real improvements and progress made since our last edition.

"We also bring a great amount of explanatory matter, such as a short treatise on drawing paper, a valuable explanation about drawing instruments, explanations of planimeters and similar instruments, an exhaustive description of the progress of surveying instruments, an illustrated paper on verniers and their application, colored details of the most improved style of graduating levelling rods, directions for reading elevations by aneroids, explanations about field glasses, etc.

"There are distributed through the catalogue a number of half-tone views (from photographs) of the several departments of our store and factories. These will be of interest also, because they will enable the reader who does not know us to distinguish between our catalogue, to a great extent of special lines and makes, and many other catalogues which are individual only on their title-page and obsolete in their contents."

The half-tone engravings referred to are admirable, but have hardly had justice done them in the printing, as the paper on which they appear is not suited for that kind of work. It is especially to be regretted that the engraving of the beautiful front of their new building has not had full justice done to it.

Probably many an impecunious draftsman will turn green with envy in looking through this book on seeing the many admirable instruments and materials used in his craft, and which are described and illustrated therein. The mere enumeration of these would take much more space than can be devoted to this subject. Those who have occasion to use drawing materials or surveying instruments should send for the book.

The Goubert Feed-water Heater ; also Engine Condenser and Distilling Condenser. The Goubert Manufacturing Company, New York. 40 pp., 6 × 9 in.

The manufacturers have here illustrated and described the various forms of apparatus which they are manufacturing, and have indicated their uses and the methods of its application. The illustrations are excellent wood-cuts, and the descriptions

are generally clear and satisfactory, but would have been more so if some letters of reference had been used in the text and in the engravings so as to designate the parts referred to. The criticism we are disposed to make is that the opening pages consist of commendation, and the descriptive matter follows. This is the salesman's method, but even from his point of view it seems to be a mistake, for the reason that to commend anything which a person operated on does not understand has very little effect. The thing to do is to give him a clear idea of the construction and operation of the thing commended, and when once this is lodged in his mind, then is the time to dilate on its merits with the kind of eloquence of which some salesmen are such masters.

In some cases, too, the explanations are inadequate. Thus, on page 8, it is said : "This shell is bolted to the lower water chamber, but is *free to expand independently of the tubes ;* its only connection at the top with the upper tube-plate being made by means of a flexible copper gasket." This is followed by a statement of the advantages of this expansion arrangement, and the reader is left to guess as best he can how it is constructed, while the next page contains an excellent sectional view of the expansion joint. If the sentence quoted had been followed by an explanation somewhat as follows : "The connection of the tube-plate to the shell of the heater is shown by a sectional view on page 9 ; *a a* is the copper gasket which is fastened to the flange *b* of the shell *c* by an annular flange or ring, *d*, and bolt, *e*. The gasket is fastened to the tube-plate and water-chamber by bolts *f*, which pass through a flange on the chamber and through the tube-plate. The annular ring *d* is slightly bevelled at *g* and the tube-plate at *h*, which permits a certain amount of vertical movement of the flexible gasket, which prevents any strain being brought on the tubes or the shell of the heater by the expansion or contraction of either," then, with such a description, the reader would have understood what followed without what may be called a break in his intelligence. The description of the condenser on pages 20 and 21 would have also been much clearer if a sectional view of it had been shown indicating how the water circulated through it.

It will be understood that our criticisms are of the catalogue and not of the heater or condenser, both of which appliances seem to be admirably suited for the purpose for which they are intended. The illustrations and descriptions of the methods of applying them on pages 12 to 21 are admirable. On page 20 it is said that with the arrangement described "the coldest water comes in contact with the hottest steam." The advantages of this might be questioned. If the coldest steam escaped into the exhaust after being in contact with the coldest water, the steam would have given up and the water absorbed more heat than would be the case if the surfaces to which the steam was exposed just before escaping were hotter. In other words, it seems desirable in feed-water heaters and in boilers to keep the coldest water in contact with the coldest heating surfaces and the hottest water in contact with the hottest surfaces.

The description of the condensers is followed by tables, one showing the yearly saving effected by the use of feed-water heaters for various H.P. and at different prices of coal, and another the percentage of fuel saved, both of which are herewith reproduced by special permission. Another table gives the "Equation of Pipes," or the number of pipes of one size required to equal in delivery other larger pipes of same length and under same conditions. Eleven pages are occupied by a list of names of parties who are used as references. On the last two pages an engraving and description of the Stratton separator are given.

TABLE SHOWING THE YEARLY SAVING EFFECTED BY THE USE OF THE FEED-WATER HEATER FOR VARIOUS H.P. AND AT DIFFERENT PRICES OF COAL.

H.P. of Engine.	Coal Consumption at 4 lbs. per H.P. per Hour.		Saving of 13½ Per Cent.	Price of Coal per Ton of 2,240 Lbs.									
	Daily.	Yearly.		$1.50	$2.00	$2.50	$3.00	$3.50	$4.00	$4.50	$5.00	$5.50	$6.00
	Lbs.	Tons.	Tons.										
50	2,000	268	36.18	$54	$72	$90	$108	$126	$145	$163	$181	$199	$217
60	2,400	321	43.33	65	87	108	103	152	173	194	217	238	260
70	2,800	375	50.62	76	101	126	152	177	202	227	253	278	304
80	3,200	429	57.91	87	116	145	174	203	232	261	289	318	347
100	4.000	536	72.36	108	145	187	217	253	289	325	362	398	434
120	4,800	643	86.80	130	174	217	260	304	347	390	434	477	521
160	6,400	857	115.69	173	231	289	347	404	463	520	578	635	694
200	8,000	1,072	144.72	217	289	362	434	506	579	651	724	796	868
250	10,000	1,340	185.90	279	372	465	558	651	744	837	929	1,022	1.115
300	12,000	1,608	226.08	339	452	565	678	791	904	1,017	1,130	1,243	1,356
350	14,000	1,876	253.26	380	506	633	760	886	1,013	1,139	1,266	1,392	1,519
400	16,000	2,144	289.44	434	579	723	868	1,013	1,158	1,302	1,447	1,591	1,730
500	20,000	2,680	361.80	543	724	904	1,085	1,267	1,447	1,627	1,809	1,990	2,170
600	24,000	3,216	433.30	650	867	1,083	1,300	1,517	1,733	1,950	2,170	2,387	2,600
700	28,000	3,752	506.20	759	1,012	1,265	1,518	1,771	2,025	2,278	2,531	2,784	3,037
800	32.000	4,288	579.10	868	1,158	1,448	1,737	2,026	2,316	2,605	2,895	3,184	3,474
900	36,000	4.824	651.24	977	1,302	1,628	1,954	2,279	2,605	2,930	3,256	3 581	3,907
1,000	40,000	5,360	723.60	1,085	1,447	1,809	2,170	2,532	2,894	3,255	3,618	3,990	4,341

PERCENTAGE OF FUEL SAVED BY HEATING FEED-WATER.

(STEAM PRESSURE 60 LBS.)

Initial Temperature of Water Entering Heater.	Heat Units Absorbed in Generating Steam.	Temperature of Water Entering Boiler.												
		120°	140°	160°	180°	200°	202°	204°	206°	208°	210°	212°	214°	216°
32°	1,175	7.49	9.19	10.89	12.59	14.30	14.47	14.64	14.81	14.98	15.15	15.32	15.49	15.66
40°	1,167	6.86	8.57	10.28	12.00	13.71	13.88	14.05	14.22	14.40	14.57	14.74	14.91	15.08
50°	1,157	6.05	7.78	9.51	11.24	12.97	13.14	13.32	13.49	13.66	13.83	14.00	14.18	14.35
60°	1,147	5.23	6.97	8.72	10 46	12.21	12.38	12.55	12.73	12.90	13.08	13.25	13.43	13.60
70°	1,137	4.41	6.16	7.91	9 67	11.43	11.61	11.78	11.96	12.14	12.31	12.49	12 66	12.84
80°	1,127	3.44	5.32	7.10	8.87	10.65	10.82	11.00	11.18	11.36	11.53	11.71	11.89	12 07
90°	1,117	2.68	4.47	6.26	8.06	9.85	10.03	10.21	10.38	10.56	10.74	10.92	11.10	11.28
100°	1,107	1.80	3.61	5.42	7.23	9.03	9.21	9.39	9 57	9 75	9.93	10.11	10 29	10.47
110°	1,097	.91	2.73	4.55	6.38	8.20	8.38	8.56	8.74	8.93	9.11	9.29	9.47	9.66
120°	1,087	....	1.84	3.67	5.51	7.35	7.54	7.77	7.90	8.(9	8.27	8.45	8.64	8.82

Recent Air and Gas Compressors. By the Rand Drill Company, New York. 32 pp., 6¾ × 10 in.

The uses of compressed air are extending so rapidly and in

so many different directions that any publication containing information with reference to the machinery and appliances used is now of interest. In the catalogue before us the subject is introduced as follows:

THE COMPRESSION OF AIR IN STAGES.

"As the advantages of this method have come to be understood, the use of compressors in which the work is done in two or more cylinders in succession has increased in popularity. For high-pressure work this process is practically a necessity, and while for the more usual pressures used in mining work the necessity does not exist, it is nevertheless true that considerable economy of fuel is secured by its adoption. The system is analogous to the working of steam through two cylinders in succession, as in a compound engine. The duplex construction of the compressor offers unusual facilities for compounding both steam and air cylinders, and this system of construction is now a marked feature of our work."

Illustrations and descriptions are then given of a duplex compound Corliss compressor, a compound compressor of moderate size, a water-power compressor with a Pelton wheel on the crank shaft, a water-power compressor belted to a turbine wheel, a duplex belt-driven compressor, a small belt-driven compressor, a duplex compressor for natural gas, a straight-line compressor for natural gas, a horizontal three-stage high-pressure compressor, a vertical three-stage high-pressure compressor, a vertical two-stage high-pressure compressor, and finally views are given of an air-lift pump and the pneumatic dynamite gun.

A summary of a report of a test made by one of our contemporaries is given in which it is said that it was shown that an ordinary railroad train brake air pump used 5¼ times as much steam as a crank and fly-wheel compressor. If this is so, there seems to be a very great opportunity for improving brake pumps.

The description of the air-lift pump is also interesting. This consists of a vertical water pipe inserted in a well, mine, or other receptacle of water, from which it is to be elevated. This pipe has an open bell mouth at its bottom. Another pipe conveys air to the bottom of the well, where the air is delivered into the bell mouth from a bend of the air pipe. The writer of the pamphlet says: "The natural levity of the air compared with the water causes it to rise, and in rising, to carry the water with it in the form of successive pistons following one another. This system of pumping has found a large range of application, and is of peculiar service in connection with deep-well pumping."

We cannot speak in very high commendation of the engravings of the catalogue, some of which appear to be made from retouched photographs and others from wash drawings. They are weak and feeble, and the printing is not first rate.

Another defect of the catalogue is that it don't explain sufficiently the construction of the compressors which are illustrated. One longs for a view of the insides of the cylinders of the pumps, and every intelligent mechanical engineer would like to know the construction of the valves and their gear when there is any.

ILLUSTRATIONS OF FILES, RASPS AND TOOLS. Issued by the Nicholson File Company, Providence, R. I. 60 pp., $11 \times 14\frac{1}{4}$ in.

A reader of many trade catalogues, which relate to mechanical engineering, has constantly occasion for astonishment at the extent and the variety of the information which is constantly being evolved and formulated concerning what we are sometimes disposed to think are very ordinary matters. Probably most mechanical engineers and machinists think that they know about all that is worth knowing concerning files. If, with this impression, they should take up the catalogue before us they will find in the beginning the statement that this company at their Providence factory alone make over 3,000 different kinds of files, which leads to the inference that there are many with which an ordinary mechanic has no knowledge. Many of these are illustrated in the admirable catalogue just issued by this company. The files are represented by excellent wood-engravings, which the publishers say they have "aimed to have made so accurate as to enable selections to be made as nearly as possible as if the files themselves were represented. The number of teeth shown is practically correct for the lengths of files illustrated."

The first page contains general views of the works and the second interior views of the offices, drawing-room, experimental department, and laboratory. These engravings are made from wash drawings, of which it may be said that they *are* very "washy." An alphabetical index may always be regarded as a means of salvation. The Nicholson Company give a very good one on page 5. A portrait of Mr. William Thomas Nicholson, the founder of the works, with a brief historical account of them, occupies page 6. Page 7 contains a wood-engraving representing the company's exhibit in Chicago, where the number of kinds of files mentioned above were exhibited. On pages 10 and 11 the sections of file steel used for making the regular kinds and sizes are shown. These sections are squares, circles, triangles, parallelograms, segments, trapezoids and other figures of which we don't know the names.

It would take more time and room than we can possibly devote to this review to describe, in the briefest way, the different kinds of files illustrated in this catalogue. These, we are told, are made in the regular grades of cut—"rough, coarse, bastard, second cut, smooth and dead smooth"—but of the peculiar arrangement of the teeth secured to this company by letters patent, and are universally known as the "increment cut files."

Of this peculiarity it is said, further:

"The arrangement of the teeth of the increment cut may be described as follows:

"1. The rows of teeth are spaced progressively wider from the point toward the middle of the file by regular increments of spacing, and progressively narrower from the middle toward the heel by regular decrements of spacing.

"2. This general law of the spacing of the teeth is modified by introducing, as they are cut, an element of controllable irregularity as to their spacing, which irregularity is confined within maximum and minimum limits, but is not a regular progressive increment or decrement.

"3. In arranging the teeth of files so that the successive rows shall not be exactly parallel, but cut slightly angularly with respect to each other, the angle or the inclination being reversed (during the operation of cutting) as necessity requires.

"In addition to the above the tooth is so formed as to have a keen edge and special shape, designed to withstand pressure and to free itself readily from chips.

"Files possessing the characteristics above mentioned do not produce channels or furrows in the work, but effect a shearing cut, for the reason that no two successive teeth in any longitudinal row of a cross-cut file are in alignment; the file is thereby able to cut more smoothly and more rapidly, and possesses greater endurance than any file whose teeth are not disposed upon the same principles."

This explanation, it is thought, might have been amplified to the advantage of the reader, as it is not obvious why the "increment" feature has the effect described. Next, what effect does the "element of controllable irregularity of the spacing" have on the action of the file; and what governs the "maximum and minimum limits"? Then, too, an inquiring mechanic will be disposed to ask what is the "special shape" of the teeth which gives the best results?

These claims are not disputed, only somewhat fuller explanation is desired.

The pages on which the files are illustrated are, many of them, illuminated with views of the works of the washy kind, but which give an excellent idea of them. The volume ends up with descriptions of "manicure" files and "corn knives," which recalls the pathetic line of poetry:

"Tall aches from little toe-corns grow."

Some other special tools, such as machinists' scrapers, bent rifflers, stub-files and holders, file-cleaners, etc., complete the volume, which is admirably printed on excellent paper and bound in limp morocco. It is a little large and unwieldy, which is the price which must be paid for having the products of this company illustrated full size, so as "to enable selections to be made as nearly as possible as if the files themselves were presented."

NOTES AND NEWS.

Patent Office Now Up to Date.—For the first time in 15 years the United States Patent Office finds itself this week up to date with its work. This means that in all of its 33 examining divisions the work is in such a condition that a new application filed to-day will be acted upon on its merits within 30 days, and an amendment filed to day will receive attention within two weeks. One year and a half ago the more important and busiest branches of the office were more than 10 months behindhand One year ago 27 divisions were more than a month in arrears; 12 were more than two months, and seven more than three months behindhand. The office force has not been increased, nor has the number of applicants fallen off. The new applications average between 700 and 800 a week, and the number of amendments about 1,600.—*Washington Evening Star.*

Early Locomotives Constructed by R. Stephenson & Co. —Corrections.—Mr. Stretton has called our attention to an annoying error in the table which gives a list of early locomotive engines constructed by R. Stephenson & Co., which was published on page 32 of our January number. Engine No.

106, named *H. Schultz*, was a six-wheeled machine with a bogie and one pair of drivers, and not a four-wheeled engine with cylinders inside, as printed in the table. No. 107, named the *Meteor*, was built for the Boston & Worcester Railroad, and had nothing to do with the Pennsylvania Railroad, as the last column of our table would indicate. No. 107, named *Kentucky*, was a four-wheeled engine with the cylinders inside, and was used on the Pennsylvania Railroad, Philadelphia Division. The error apparently occurred from the printer placing the details in columns six and seven one line too high.

But misfortunes and mistakes never come singly. On page 12 the date when the *Planet* was put to work is given as October 30 ; it should be October 4. The weight in driving-wheels is given as 8 tons, 2 cwt. 2 qrs. It should be 5 tons, 8 cwt. 2 qrs.

The International Railway Congress.—The members of the International Railway Congress, according to the Glasgow *Herald*, will leave London for Glasgow on July 10 next, and will visit all the principal railway works and centres in Scotland, the excursion forming a termination to the eight days' meetings at the Imperial Institute. The proceedings will begin on the afternoon of June 26, when there will be a ceremonial opening, at which the Prince of Wales is to preside, and then the members will go for three days on excursions to Lancashire and elsewhere, settling down to business on Monday, July 1, and continuing until they start for Scotland. There are to be five sections ; and already the reports which are to form the bases of discussion have been prepared, the reporters having been named months ago. In section one an English and an Austrian expert will report on permanent way for high speeds ; a French expert on special points in permanent ways ; an Italian on junctions ; and an Austrian on bridges. In section two a Frenchman will report on boilers ; an Englishman on express locomotives ; another on express trains, and a Frenchman on electric locomotives, and so on through the other three sections, dealing with traffic, with light railways, and with general questions. There are in all 31 writers of reports—12 English, six French, four Italian, three Austrian, three Belgian, two Russian, and one Roumanian.

An Old, Old Story.—The letter, of which the following reprint is a copy, it will be seen was dated as far back as 1835, and was addressed to Mr. Horatio Allen, who was then an officer of the South Carolina Railroad. The same kind of story has been told thousands of times since then, but perhaps never more graphically than by Mr. Fairy :

Addressed To The Honrl Maj'r Allen of Charleston, S. C. :

State of South caroline Orangeburg District To the rail road and company I have again taken the opertunety of riting to know if you received my letter dated the 11 wich I heir giv you to under stand that your steam carr have killid a Fine young cow for me wich left a calf a few days old wich perished for want of its mother wich cow was kilid the 7 of Febuary also a bout two weaks before this i had a fine sheap yew mashed to death on the road wich left a fine lam wich also perished and died for its motr I asked Mr Roeth his advise about it he told me i shod git two men that knew the cow and value her as if on oath wich men hav said she where worth twenty Dolars the sheep three Dolars also your road have went throo my Land without my leaf I leave it to your chois pay me for my cow and sheap or moove your road round my field you have burnt my fens and i want my fens maid as soon as posibel i lived in peace before your rail road came throo my land you promis to make a bridg in my field wich has not bin don I wish ad answer or my money as soon as possibel Mr Alen

March the 16 1835

John W. Fairy two miles below branchvil.

Wages of Railroad Men—In its last annual report the New York Central gives information as to the average yearly income of different classes of its staff. I quote a few figures :

	Per annum.
Engine drivers	$1,200
Firemen	650
Station-masters	630
Passenger conductors	1,000
Brakemen and baggage masters	630
Clerks in the head office	800
Telegraph clerks	600
Signalmen and switchmen	500
Section foremen	600
Section men	420

We may, no doubt, assume that the New York Central pays as high as any company in the Eastern States, and on this basis it will be evident that when we allow for the different cost of living, for the fact that American railway berths are by no means like ours—a provision for life—and carry with them practically no additional advantages in the shape of pensions and superannuation and accident funds, and so forth, American railway men are not on the average much, if at all, better off than ours. Another point that will strike everybody is the very different graduation of salaries in England and America.

That the average station-master should be paid less than a fireman, less than two-thirds of the wages of a guard, and only a very little more than half the wages of an engine driver, will no doubt strike an English reader as very curious. We must of course, however, remember that while, on the one hand, the American station-master deals only with very few passengers and with still fewer trains in the day, the duties of a driver on railways with no block system and with no fences, working engines habitually loaded up to their maximum capacity, are both immensely more hazardous and vastly more responsible and difficult than is the case in this country.—*Transport.*

A Comparative Test of Water-Tube and "Scotch" Marine Boilers.—The Chicago Ship-Building Company have recently taken a contract for several freight steamers which are to be 405 ft. over all, and of 6,000 tons capacity. One of these is to be supplied with "Scotch" and another with Babcock & Wilcox water-tube boilers. The Chicago Ship-Building Company offered to place these two steamers at the disposal of the United States Bureau of Steam Engineering for test as to the comparative merits of the two types of boilers. This offer has been accepted by Commodore George W. Melville, Chief of the Bureau, who sent the following reply in response to this offer :

Department of the Navy,
Bureau of Steam Engineering,
Washington, D. C., January 31, 1895.

To Chicago Ship Building Company, One Hundred and First Street and Calumet River, Chicago, Ill. :

Gentlemen : The Bureau will be pleased to accept your generous offer, and will endeavor by all means possible to make the test as complete and as comprehensive as possible, in order that there may be no question about the result. The opportunity is an unusual one, the identity of the two steamers, except in boilers, being such as to eliminate many points of contention which have arisen when similar ships have been tried with different types of boilers, but also with modifications in the engines or screws and thus left room for controversy afterward.

The Bureau will be quite ready to co-operate with you later regarding the arrangements for the tests, which it believes will be of great interest in themselves and valuable to the engineering profession generally.

In conclusion, the Bureau wishes to say that this offer of yours is a very generous one and one that is highly appreciated ; and the liberality which inspires it can but win the admiration of the engineering world.

G. W. Melville,
Engineer-in-Chief, U. S. N., Chief of Bureau.

These tests, which will be conducted with the thoroughness characteristic of everything done by this Bureau, will be very interesting, and the information which will be gained therefrom will doubtless be very valuable.

Large Gas Engines.—We have from time to time noted the increased sizes of gas engines that are being introduced for various purposes, and it would seem that the great economy that has been developed in their operation of small powers is gradually working its way into the larger machines. The *Portefeuille Economique des Machines* recently published a description of an exceedingly large gas engine that has been built by Messrs. Delamare, Deboutteville & Malandin for the mills of M. Abel Leblanc, near Paris. The engine is a remodelled type of the *Simplex*, and differs somewhat in the details of its construction from the 100-H.P. engines heretofore constructed. In order to appreciate the dimensions of the machine as compared with those that have preceded it, it will suffice to say that from 80 H.P. to 100 H.P. is the most that they have realized, using common illuminating gas. These new engines, however, will develop 450 H.P. with the same gas. In an actual test with low-grade gas, 320 I.H.P. have been obtained. The engine is of the single-cylinder type, and it is 34¼ in. in diameter, with a stroke of 39⅜ in., making 100 revolutions per minute. The fuel used is the fine coal from the mines of Anzin. As a brake test with such a large motor would be exceedingly difficult, and as the mill could not be stopped for the purpose, but must be kept running night and day, the test was made under the actual running conditions and this was done in the following manner ; Two cars, containing

22,000 lbs. of coal each, were set aside, and the gas generators were filled to the top with the old store of coal and time carefully noted. The mill was loaded according to a predetermined production, and indicator cards were taken at frequent intervals during the test to determine the effort that was being exerted upon the piston. When the two carloads were exhausted, the time of the last filling of the generators was noted, and it was found that the coal had lasted for 194 hours. The cards showed that more than 280 I.H.P. had been developed, and this corresponded to about 220 brake H.P. The computations show, no deductions having been made for ash, that the consumption was about 0.81 lbs. per I.H.P. and 1.03 lbs. per brake H.P. per hour. Three months afterward a second test was made, in which the figures just given were duplicated. These results are so remarkable that they deserve to attract the attention of engineers, electricians and manufacturers, as they are far below the most efficient steam engines that have thus far been constructed.

Compressed Gas for Barge Propulsion.—Compressed gas has been used for some time for the propulsion of small vessels, such as launches and pleasure craft; but recently a company has been formed at Havre for the purpose of establishing a line of barges to ply on the Seine between that point and Paris that are to be propelled by gas engines, and carrying their own supply of compressed gas. The gas is produced at a small gas works situated midway between the two places, where the gas is compressed to a pressure of about 1,400 lbs. per square inch, and is stored in special gas-holders. When the supply of gas on the barge is exhausted it is quickly replenished by connecting it with the pipes leading to the storage tanks. The first barge to be fitted is an iron vessel having a length of 98½ ft., a breadth of 18 ft., and drawing 7 ft. 4½ in. of water. It is divided into four water-tight compartments, in the forward one of which are located the quarters of the captain and the crew. The cargo is carried in the two central compartments, while the engine is placed in the stern. The gross tonnage of the vessel is 300, but the quarters of the crew and the space occupied by the engine are so small that a cargo of 250 tons can be carried. The gas is stored in steel tubes having an outside diameter of 9.84 in. and a thickness of 3.1 in. and a length of 16.4 ft. Each tube weighs 715 lbs. and will hold 777 cub. ft. of gas at a pressure of 1,400 lbs. per square inch. They were, however, tested at a pressure of 2,250 lbs. There are 80 of these tubes, and they are connected to each other by flexible tubes, the joints of which have been tested to the same pressure as the tubes themselves. In order to prevent accidents and economize space they have been placed on the captain's bridge, so that should any leakage occur there can be no danger, as the gas will escape directly into the atmosphere. The gas is expanded down to the desired pressure for the engine by a special apparatus. The engine is of the vertical two-cylinder type of about 40 H.P., with the cranks set at right angles. On one end of the shaft there is a fly-wheel used for starting the engine. The vessel is equipped with a two bladed reversible propeller by means of which different directions or speeds may be given to the boat without stopping or reversing the engine. On the occasion of a trial trip, when the vessel was loaded with 80 tons, a speed of about 6½ miles per hour was attained with the engine running at 200 revolutions per minute, and the propeller worked well both ahead and astern, and stopped without affecting the engine in any way.

The Atlanta Exposition.—The interest felt in the exposition that is to be held at Atlanta, Ga., during the coming fall is growing, especially in the South. State exhibits will form a very important feature of the exposition. At first they seemed tardy, but of late a number of States have taken active interest in the Exposition, and some at a distance seem as much enlisted as those adjoining Georgia. Georgia, Florida, Alabama, North Carolina, Louisiana, Arkansas, Illinois and New Mexico is the list up to date. Some of these have not taken definite action; but it is probable that all of them will be represented, and others are expected to come in. The great railroad corporations of the South will have an important part in the Exposition. The Southern Railway will erect a building of its own near the entrance. The Plant system, of Georgia and Florida, with steamer connections in the West Indies, will be handsomely represented. Colonel D. H. Elliott, Land Commissioner of this system, who has the exhibit in charge, writes that it will take the form of a pyramid 100 ft. square at the base and 50 ft. high. The Flagler system, of Florida, will be handsomely represented at the Exposition, and Mr. J. E. Ingraham, its representative, has been appointed by Governor Mitchell as Commissioner for the State exhibit. Colonel W. D. Chipley, who represents the Louisville & Nashville system in Florida, with headquarters at Pensacola, is Assistant Commissioner, and has already applied for large space for a West Florida exhibit to cover ten counties in the hill country between Tallahassee and Pensacola. Paraguay was the last foreign country to announce an exhibit at this exposition. The list now includes Mexico, Venezuela, Honduras, Nicaragua, the Argentine Republic, Paraguay, Italy, Austria-Hungary and probably Greece. The exhibits from Italy and Austria Hungary will be secured by special commissioners, who performed the same service for the World's Fair. Italy will cover 10,000 sq. ft. and Austria-Hungary 5,000 sq. ft. In the same way it is proposed to secure exhibits from England, Germany, France and Belgium, covering about 15,000 sq. ft. So far applications for space have been received from Canada, England, Switzerland, France, Japan and Tasmania. Great activity is shown among the textile industries of England, particularly at Bradford, the seat of the woollen industry. This exposition will not be without picturesque features. There will be a Mexican village, a Guatemalan village, an Oriental village, and probably a Japanese garden. The last mentioned will be one of the most unique and beautiful features of the fair.

The Water Level in the Lakes.—The probable effect of the opening of the Chicago drainage canal upon the water level of the great lakes has been the subject of discussion ever since that tremendous project took shape. A cry of alarm was raised several years ago when it was announced that the diversion of water from Lake Michigan in anything like the quantity required to fill the canal then being constructed across Illinois to the Mississippi Valley would seriously interfere with the navigation of the St. Clair and Detroit rivers, and render it impossible for heavy draft vessels to enter most of the harbors on the lower lakes. The Chicago engineers have done their best ever since to dispel that belief. They have maintained that the taking from the lakes of all the water that will ever be required for the canal will not lower the lake level more than 3 in., and the Chicago newspapers have all endorsed the opinions expressed by the Chicago engineers, as a matter of course.

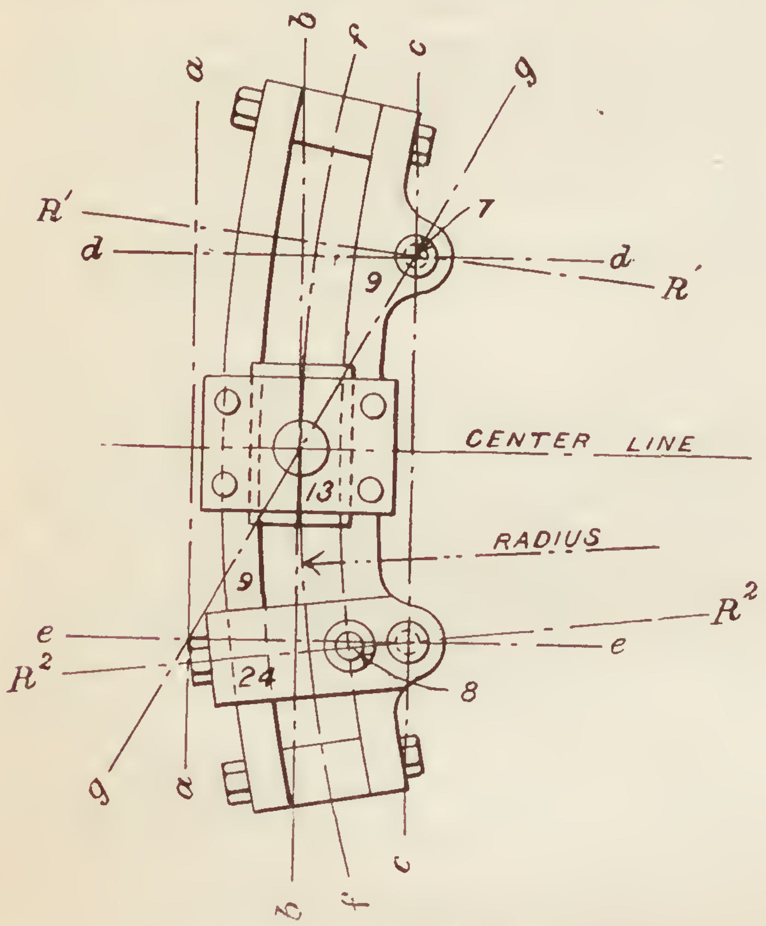
Professor G. Frederick Wright, of Oberlin College, who has perhaps made a more careful study of the geology and geography of the lake region than any other man in the United States, does not agree with the Chicago engineers, however. Professor Wright shows that the quantity of water required to be turned into the drainage canal when it is first opened will be equal to about 5 per cent. of the quantity that now flows over Niagara. When the population of Chicago reaches 2,000,000 the law under which the canal was constructed provides that the quantity of water passing through it shall be doubled. That means that at least 10 per cent. as much water as now passes over Niagara will be diverted from the lakes to the Mississippi. Major Ruffner, of the Corps of Engineers of the United States Army, estimates that when the drainage canal is first opened the result will be to lower the level of Lakes Michigan, Huron and Erie and the connecting rivers at least 9 in., and that when the canal is operated to its full capacity the fall in the water level will be 18 in. This, Professor Wright says, may have but little effect in the rainy season, but during the late summer and autumn he is certain that it will seriously interfere with navigation. He declares that the vessel owners and all who are interested in the commerce of the lakes should realize the danger and do all they can to avert it. As a preventive measure he suggests that a dam be constructed across the lower end of Lake Superior at the "Soo," which will raise the level of that lake 2 ft. and store enough water during the rainy season to supply the lower lakes during the late summer and fall.—*Cleveland Leader*.

WARREN'S IMPROVED LINK.

Editor of THE AMERICAN ENGINEER AND RAILROAD JOURNAL:

I noticed in the AMERICAN ENGINEER for December a description of the improvement in the link motion patented by me, and which does not describe clearly the advantages of the invention and the claims of the patent. As you will please notice, I have reserved the right to change the location of the eccentric-rod coupling-pin holes in a horizontal direction to correct any point of cut off, and still retain the eccentric-rod couplings at unequal distances from the centre of the main shaft. Referring to the figure herewith, which is a side view of a skeleton link, of which the saddle-pin 13 is on the centre line of the link, and the eccentric-rod coupling-pin hole 7 is located 3 in. from the centre line *f f*, or in the usual position on ordinary links. The eccentric-rod coupling pin 8 is located ½ in. from the centre line *f f*. Both are on radial lines R^1 R^1 and R^2 R^2. You will notice that the eccentric coupling-pin 8

is made with a saddle connection, 24. On no two link motions of different design will the location of the eccentric-rod coupling-pins 7 and 8 come alike, and therefore the saddle 24 is left adjustable until the proper location is found, and it is then bolted permanently to the link. On ordinary link motions with main rods from 7 ft. to 7 ft. 6 in. and eccentric-rods 4 ft. 6 in. to 5 ft. 8 in. and links from 11 in. to 13 in. long, the location of the pin 8 will range from ¼ in. to 1¼ in. from the centre line *f f*, and the position of the pin 7 will vary from 2⅝ in. to 3 in. from the centre line *f f* in order that the valve will cut off equally for each end of the cylinder in the forward motion,



WARREN'S IMPROVED LINK.

and at the same time the valve will cut off accurately in relation to an equal travel of the driving-wheel on the rail when the gear is in the back motion, and which thus gives a very good working engine. I have it applied on a few locomotives here on this line (the Toledo, Peoria & Western Railway), and it has been doing good work for some time past. It is found to save three-fifths of the usual slip of the link on the block on those engines I have tested, and it is immaterial which eccentric-rod coupling is used for the forward motion, but I prefer to use the lower pin for the forward motion.

W. B. Warren,
General Foreman T. P. & W. R. R. Shops, Peoria, Ill.

WATER HAMMER.

Editor of The American Engineer and Railroad Journal :

Can you or any of your readers tell me how to prevent water hammer in steam pipes? I am a resident in an apartment house in New York, which was built 10 or 15 years ago, and consequently the steam fittings are not of the latest or most approved form or design. In the morning, an hour or more before it is time to get up, just when I am having that last nap which is most enjoyable, the —— steam pipes, or rather the water in them, begins to hammer. If a boiler-maker was let loose in my room he could not make a more disagreeable and disturbing noise than the steam pipes emit. Being of a nervous temperament, this wakes me up so effectually and results in so much profane thinking that sleep is impossible thereafter. The company which put the steam fittings in the house have been consulted without avail, the night engineer has been bribed (tell this not to the Lexow Committee), the agent of the building anathematized, but the hammering and its consequent profanity still continues. That steam pipes can be arranged so that there will not be any hammer is, of course, well known ; but those in my rooms are not so arranged. What I want to know is how the water hammer can be prevented in the pipes as they now are. If any of your readers can inform the writer how this disturbance can be prevented, my imprecations will be changed to blessings which will be invoked on the person or persons who will prescribe a cure for the present annoyance.

X. Y. Z.

New York, December 19, 1894.

THE EFFICIENCY OF THE JOHNSTONE COMPOUND LOCOMOTIVE.

Editor of The American Engineer and Railroad Journal :

I see by your paper for this month a very interesting article on the performance of the Webb compound and simple engines, as compared with the Buchanan express engine, and in reply to your call for some of us compound men to show what our engines are doing, I herewith hand you statement of performance of six heavy freight engines, embracing three years of actual service, as compared with 17 simple engines of equal capacity and in the same service, embracing a period of four years' actual service.

These engines were in service upon the Mexican Central Railroad, working on a division with 1½ per cent. maximum grades.

A statement, showing the performance of these six compounds and 17 bogies for a period of more than three years, shows the average trains of the compounds, in cars and their contents, to be 216 tons ; that of the simple engines, 207½ tons.

The rating of these engines is 440 tons on 1½ per cent. grade, therefore the average train was less than one-half the capacity of the engines. This is due to the fact that the business is pretty much all in one direction, going south into Mexico, while the trains out of the city run light.

We find that the compounds use 79.2 lbs. of coal, and the simple engines 98.1 lbs. per train mile. In comparing this performance on coal with that made upon other roads, a number of circumstances should be considered. As shown above, the trains only average one-half the capacity of the engine, and as there is only one coal mine in Mexico with a limited output, this road is obliged to get their supply of coal from the United States and from Europe. Owing to strikes in the United States and delay to imports from Europe, we are often obliged to get coal from a number of different places, and during the last three years these engines have been obliged to burn more than 12 different kinds of coal, varying in quality from *briquetts* of pressed fuel from England, which has high steaming qualities, down to inferior grades of coal, which we were forced to use under the circumstances, the quantities of these different coals varying from 5 per cent. to 25 per cent. of the total quantities used by the locomotives.

Under these conditions the most skilful firemen cannot produce the best results when obliged to change frequently from one class of coal to another.

Under these conditions the consumption of coal per ton-mile of cars and their contents shows 5.856 oz. for the compounds and 7.520 oz. for the simple engines. This performance of course includes raising steam, switching at all stations, laying on side tracks waiting to make meeting points, and is the performance of engines not always in first-class condition, as it embraces a train mileage of 667,110 miles for the compounds and 2,251,548 miles for the simple engines.

I do not think any comparison can be made between such tests as these and the little teaspoon test, embracing less than 100 miles on comparatively level track, shown in the statement in your issue of December, 1894.

I would call your attention to a series of tests made by Mr. D. L. Barnes with one of my compounds in 1892, after the engine had been in constant service for seven months. These tests embrace a train mileage of 1,180 miles in actual service, tests being made with trains coming south from San Juan del Rio to Mexico, trains approaching in weight to the rating of the engines.

With Colorado soft coal the performance of these engines on this division, with 1½ per cent. maximum grades, shows a consumption of coal varying from 3.36 oz. to 3.82 oz., or an average of 3.56 oz. per ton-mile of cars and contents.

With English patent fuel the performance varied from 3.07 oz. to 3.87 oz., or an average of 3.37 oz.

Now, to show the difficulty of comparing the performance of engines working on 1½ per cent. grades with those working on divisions of track with, say, ½ per cent. grades, let us take the following figures :

For divisions with maximum ½ per cent. grades, these compounds are rated at 1,085 tons of cars and contents, and considering that these engines were worked as hard over such a division as they had to work between San Juan del Rio and Mexico over maximum 1½ per cent. grades, and taking their worst performance on Colorado soft coal, which was 94.1 lbs. per train-mile as the consumption, the performance would be 1.387 oz. per ton-mile of train and contents.

Again, if we compared the performance of these engines with engines running on practically level track, as was the case in the tests of the Webb and Buchanan engines, the figures will stand as follows:

Engines rated at 2,600 tons and allowed 94.1 lbs. of coal per train-mile, we would have a performance of 0.579 oz. per ton-mile of cars and contents.

I think these deductions are not unreasonable, as in all cases where small special tests are made care is taken to have the weight of train approximate the rating of the engine, the best coal is selected, the most skilful men are put in charge of the machine, the engines are in first-class condition, and the tests are invariably made on through runs, where little or no switching is done and long delays at meeting points are avoided as much as possible. Under such conditions, on comparatively level track, I am satisfied my compounds would show a performance of less than 1 oz. per ton-mile of cars and contents.

Yours very truly,
F. W. JOHNSTONE,
Supt. M. P. & M.

PERFORMANCE OF SIX COMPOUND AND SEVENTEEN SIMPLE ENGINES ON THE MEXICAN CENTRAL RAILWAY, SHOWING MORE THAN THREE YEARS' WORK IN REGULAR FREIGHT SERVICE.

	Six Johnstone six-coupled compound freight engines, in service from Oct. 1, 1890, to Nov. 1, 1894 — 37 months. For dimensions, see pamphlet.	17 bogie engines. 20× 24 in. cylinders, 49 in. drivers, 103,000 lbs. on six drivers, in freight service from Oct. 1, 1890, to Nov. 1, 1894—49 months.
Weight of locomotive and tender in working order.	97 tons of 2,000 lbs.	97½ tons of 2,000 lbs.
Average weight of trains in cars and contents...	216 tons of 2,000 lbs.	207½ tons of 2,000 lbs.
Ratio of weight of locomotive and tender to weight of cars and contents....	1.00 to 2.22.	1.00 to 2.12
Total train miles....	667,110	2,251,548
Average speed (actual running time)....	20 miles per hour.	20 miles per hour.
Consumption of coal per mile run, including raising steam	79.2 lbs.	98.1 lbs.
Consumption of coal per per ton mile of cars and contents, exclusive of locomotive and tender, including raising steam, switching at stations, and waiting at meeting points	5.856 oz.	7.520 oz.

[To those of our readers who are not familiar with the construction of the Johnstone type of compound locomotive, it may be said that it possesses the radical difference from all others that have been built, in that its compound feature consists in the use of a large cylinder upon each side of the engine, which serves as the low-pressure cylinder, and that the high-pressure cylinder is enclosed within it. Thus the low-pressure cylinder is actually annular in form. There are three piston-rods for each side, all attached to the same cross-head; two take hold of the low-pressure piston at the top and bottom respectively, and the other is attached to the high-pressure piston. The locomotive is therefore a four-cylinder compound, with only one cylinder apparent on the outside. The following are the general dimensions of the engine referred to in Mr. Johnstone's letter.—ED.]

Weight on back driving-wheel	36,000 lbs.
" " centre "	36,100 lbs.
" " front "	31,820 lbs.
" " " truck	29,320 lbs.
Total	133,280 lbs.
Diameter of cylinders	13¾ in. and 29½ in.
Stroke of pistons	24 in.
Centre to centre of cylinders	85 in.
Out to out of frames	48 in.
Type of boiler	Belpaire.
Size of firebox	120 in. × 41 in.
Length of tubes (in to in of tube sheets)	12 ft. 10¾ in.
Diameter of tubes, outside	2 in.
Number of tubes	278
Centres of tubes	2¾ in.
Grate area	27.3 sq. ft.
Heating surface, tubes (outside)	1,800 sq. ft.
" " firebox	204 sq. ft.
" " total	2,004 sq. ft.
Thickness of boiler sheets (barrel)	⅝ in.
Travel of valves to H.P. cylinder	5½ in.
" " " " L.P. "	4½ in.
Tractive force per pound of E. P. per sq. in.	81.91 high-pressure cylinder, 371.3 low " "
Date when built	1891
Diameter of driving-wheels	56 in.

YARD ARRANGEMENTS ALONG HEAVY-TRAFFIC HIGH SPEED RAILROADS.*

By A. FLAMACHE.

THE arrangements that have been thus far adopted for the yards of intermediate stations and junction points have been planned in a way that is very favorable to the local operation of the station; but sufficient attention has not been paid either to the importance of the traffic on the branches or the intensity of the through traffic. High-speed traffic that could formerly be disregarded is increasing from day to day, and the average speed of the trains is also on the constant increase. It has, therefore become necessary to take into consideration the new element that the demands of the public have introduced into railroad operation. Now, experience has shown that it is impossible to even think of establishing a rapid communication over a complicated system of railroads unless all necessities for slowing down are removed. Junction stations, drawbridges that are so numerous on some lines, must be so located that the average running speed can be maintained without danger. Let us take an example to prove our case. During the bathing season a train making the daily run between Brussels and Ostend runs the 65 miles between the two cities in 104 minutes, which gives an average running speed, including stops, of a little more than 43½ miles per hour. At the time that it was put into service this train was one of the fastest, if not the very fastest, on the Continent. Its running speed on a clear track averaged about 52 miles and sometimes rose as high as 56 miles per hour, but rarely exceeded 62 miles. At 52 miles per hour it could make its run in 87 minutes, or, allowing for stopping and starting, 90 minutes. The difference of 14 minutes is due to the regular slowing at 12 junctions on the main line, two drawbridges, six important stations with junctions, 25 intermediate stations, and one stop of two minutes at Bruges. It will be readily acknowledged that it would be impossible to make this run and lose no more than 14 minutes. But these few minutes are sufficient to lower the commercial speed from 52 to 43½ miles per hour—that is, it drops from the high speed of the *Flying Dutchman* to the more moderate speeds of the continental trains.

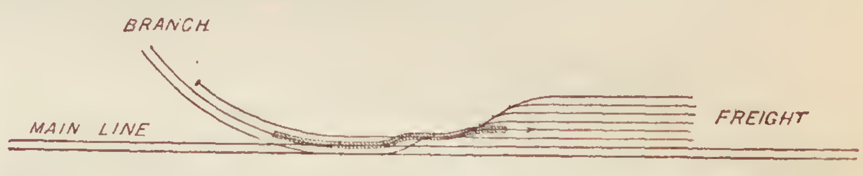


Fig. 1.

This single example serves to show the important effect that slowing-down points have on the commercial speed of trains and the absolute necessity of doing away with them if it is considered desirable to increase the speed of through and interurban trains. I will occupy myself solely with the *possibility* of running fast trains; but the question of *safety* is one that will continually arise. To pass through stations where the main line is occupied for a greater portion of the day at anything more than half speed except when there is a special announcement of the fast train is a genuine case of imprudence. Statistics show that, since the general adoption of interlocking apparatus, collisions at junction points have almost entirely disappeared, that the collisions out on the line have been diminished by 90 per cent., and that now 95 per cent. of the accidents that happen take place at way stations. But speed and safety can only be insured by avoiding all interruptions of the main line at the principal stations and by affording to slow trains that are followed by fast ones a chance to get quickly off from the main line. The object of this note is to examine into the best methods of accomplishing this from the standpoint of the arrangement of station yards.

In the following study I have had the lines of the Belgian State Railway especially in my mind, where the following conditions are met with in a high degree, to wit: a complicated system with a crowded local traffic and traversed by high-speed international trains. We can say in regard to the important stations that they can be considered as the literal counterpart of the general average of such points, where the main lines are considered as the arteries into which the local services flow and upon which they make their connections. It would seem that there is no disadvantage in thus occupying them. At some stations switching is carried on all of the day; at others the junction points of the branch lines are made at some distance from the entrance to the freight yard, and are situated on the

* Bulletin de la Commission Internationale du Congrès des Chemins de fer.

same side, so that a long freight train can be handled and occupy only a small portion of the main line while the work is being done, as shown in fig. 1.

I cannot end my criticisms without saying that the conditions most favorable for high speeds are exactly those that are diametrically opposed to what is most generally adopted. Doubtless the disadvantages that exist have been seen by many engineers. Isolated attempts have been made to improve them, but as they lacked continuity of effort the results have been fruitless. That is why I have considered it advisable to prosecute this work with the idea of bringing out what has been done on foreign roads as well as our own; the arrangements that have been adopted in England acting as a special inspiration.

What are the station arrangements, that, while permitting the local work to be prosecuted without interruption and with the greatest ease, will, at the same time, be most favorable to through traffic?

I have not given examples that can be found in any technical publications, the teachings of which it is difficult to discern. I have, rather, dissected those plans that have been recognized as the best in order to discover their fundamental parts and describe them, leaving to the engineer to group them and make the application to the particular cases that may arise for his solution.

Experience has taught me that there is frequently a great deal of difficulty in making an application of arrangements to a given situation that would be recognized as good in others. Furthermore, I would beg the reader not to attach himself too closely to arrangements that are made for a purely local traffic; for, while the strictest possible attention should be paid to the principles that will be laid down for the traffic of a main line, there are some local arrangements that should be viewed purely from the standpoint of the special needs of the station work. In my opinion, a great deal of latitude should be allowed in this respect as to the number of side tracks, their connections with each other, and the uses to which they are to be put. The general principle from which the least possible variation should be made in the arrangement of stations located along the main line of a heavy-traffic road is the following:

The main tracks should be considered as the exclusive domain of the trains in transit. Trains should be prohibited from standing on these tracks; they should not be crossed, and the local service and switching should be conducted independently of them.

On the other hand, the arrangements should, first of all, yield to the service of the high-speed trains. Consequently:

1. The contour and profile should be as straight and level as possible from one end of the yard to the other. The changes in curvature and gradients should be limited to that which is absolutely necessary. For no reason whatever should the radius of the curves be allowed to drop below that which is permissible for the open lines where the highest speed is maintained. All switch connections should be trailing, unless such an arrangement introduces sags or changes in the level of the main line.

2. The number of switch stands, signals, crossings, frogs and points should be as small as comports with the necessary connections of the local tracks. These constitute not only causes of shocks by breaking the continuity of the rails, but afford means of access whereby obstructions can get upon the main line.

3. The distance included between the extreme limits of the yard should be made as short as possible, in order to increase the length of the main line where the normal speed can be maintained.

4. The local service should not require, except in cases beyond control, that the main line should be crossed. As far as possible all of the local tracks or sidings should be on one side of the main line. When it is to be crossed, bridges or underground passages should be used. The side-tracking of trains, either by backing in or running in head-on should not require the crossing of the main line.

5. The whole extent of the yard, from one limit to the other, should be free and clear of every change and obstruction so as not to introduce intermediate signals, whereby the driver will be compelled to run with the train under control.

6. The connection of the sidings with the main line should be so laid out that the latter can be cleared in the shortest possible time. Every train that stops on the main line constitutes an obstruction, and its presence there is troublesome.

Under these diverse conditions, there are some points that are difficult to harmonize. Thus one could only separate the local service on the two sides of the main line, when they had very slight relationships with each other. We will cite an example of this further on. But, I repeat, that these are general principles that ought to be observed as far as possible, especially the fourth, which I consider to be the most important of the lot. The considerations that will follow will show how they can be applied to concrete examples.

(TO BE CONTINUED.)

MEETING OF MECHANICAL ENGINEERS.

THE ELECTRIC MOTOR IN THE MACHINE SHOP.

THE second of the series of meetings arranged for mechanical engineers was held at the house of the American Society of Mechanical Engineers, No. 12 West Thirty-first Street, New York City, on Wednesday evening, February 13. Mr. Henry R. Towne presided, and the subject for the evening was that given in our headlines. The opening paper was read by Mr. George Richmond, of the De La Vergne Refrigerating Machine Company, and was as follows:

Your committee in charge of these monthly meetings has asked me to introduce for discussion the subject announced for this evening—namely, that of the Electric Motor in the Machine Shop.

I must disclaim at once any special fitness for this duty; and the apology which your committee has been kind enough to furnish for me that in my connection with the De La Vergne Refrigerator Machine Company I have had an opportunity of studying this question would have more force if I could assure you that I had availed myself of this opportunity, which I have not. Even if the contrary were true, you must remember that this installation at the De La Vergne Company was made in 1892, and at the rate at which electrical engineering proceeds, it is now ancient history, and I should be almost ashamed to put forward three-year-old fossils.

But it is the privilege, if not the universal attribute of ignorance to be unprejudiced. Not only have I no axe to grind, but I am absolutely without any strong convictions on the subject. On the contrary, I expect to get, if not religion, at least electricity this evening; for nowadays electricity is almost a religion, and it requires some courage to acknowledge one's self an agnostic.

The present state of the art may be very briefly presented, and for this purpose it is not necessary to consider the subject of electrical transmission in general. The possibilities of long-distance transmission are no longer in question. The relative economy in comparison with other methods of transmitting power may be considered as still an unsettled question, although the extreme simplicity of the electrical methods will undoubtedly have a preponderating influence.

A very great advantage has been found in the substitution of motors for local steam engines in such places as rolling-mills, dockyards, etc., and this was altogether to be expected. Some interesting data in this connection are contained in a paper read by D. Selby-Bigge before a meeting of the Iron & Steel Institute, an abstract of which is to be found in the *Engineering Magazine* for December. He gives as an example of the economy effected, a case where six steam engines, aggregating 94 H.P., were replaced by motors aggregating 29½ H.P. While it may be said that such figures prove too much, they unquestionably show that there are many cases where extravagant waste of power occurs in transmission; and if the advocates of other systems have slept upon their rights, it is perfectly just that electricity should step in and claim all the glory. Nevertheless, it would be interesting to compare with a so easily won victory some other solution of the problem—say, for example, that of the gas engine operated with producer gas—for it is well known that gas engines do not fall off in economy with such frightful rapidity with decreasing size as do steam engines, and, moreover, the losses in transmission through pipes is trifling compared to that of steam.

Leaving out of consideration the substitution of motors for steam engines, there remain three forms of application of the principle of special interest to the mechanical engineer—namely:

1. The driving of isolated tools where convenience is a chief consideration.

2. The grouping of a number of machines around a motor admitting of an infinite number of combinations—from that of two or three machines to that of all those on the same floor or in the same shop.

3. The building-in of a motor as a part and parcel of each and every machine tool.

There are a number of examples in this country of the first method, among the best known of which are those of Fraser & Chalmers and the De La Vergne Refrigerating Machine Company. Probably many present have seen the arrangements in the latter case for driving the heavy tools in the erecting shop.

The full advantage of direct coupling could not of course be obtained in this case, but the necessary countershafting is attached to the walls of the building, well out of the range of action of the travelling crane. There are in all nine motors of the C. & C. type, including three for the Morgan crane. The aggregate capacity is 75 H.P. It is found by experience that a single 40 H.P. dynamo is sufficient to supply these motors, although it is rather severely taxed when the crane is being operated at the same time that the planing machine is running on a short cut. The average H.P. supplied by the driving engine during a test extending over six weeks was 24 H.P. As this engine was of 100 H.P., so chosen in view of possible extensions, we may deduct 10 H.P. for friction, leaving an average of 14 H.P. supplied to the dynamo. If there are still any advocates of the storage battery, such a case as this presents an opportunity of figuring on the economy of running this whole plant with, say, a 20-H.P. engine in combination with storage batteries.

With regard to the second method, we have much more valuable data in connection with the installation at Herstal, Belgium. In this case we have the advantage of the deliberate choice, based on a careful scientific inquiry and the carrying out of the plan, without any of the compromises necessary in plants already running. A reprint of two important papers, the one by Leon Castermans, Managing Director of the Government Rifle Factory at Herstal, and the other by Felix Melotte, Engineer for the International Company of Electricity, which supplied the electric plant, has been made by the C. & C. Company, and should be in the hands of every one interested in the subject. It is hardly necessary to say that both these gentlemen are enthusiastic advocates of the system adopted; and since they have between them enumerated pretty nearly all the advantages of the same, I cannot do better than read these as propositions for the consideration of the members of this Society. Mr. Castermans, with the ardor of a proselyte, is willing to venture on debatable ground and somewhat broad generalizations. His statement of the advantages is as follows:

1. By the simplicity of its parts, the security against interruption is greater than in other mechanical systems.

2. The elimination of belts, cables, pulleys, countershafts, etc., diminishes enormously the chances of accident or interruption.

3. This system is the only one which will give accurate figures as regards power transmitted and delivered.

4. This system it is which presents the smallest disproportion between effective work and the passive resistance of the transmitting device, and which consequently gives the highest average efficiency.

5. The quantity of masses in movement is less than in any other system.

6. Electrical transmission is especially advantageous from the point of view of future enlargements in a factory. In fact, as each of the motors takes its power directly from the main motive power, it is always possible to put in new motors without affecting the original installation.

7. From the point of view of interior service, it is the only system which offers the possibility of easily disconnecting each transmitting shaft, and, what is more, of varying the speed of each of the elements independently of the others, which can continue to run at their normal speed; this last point offers one of the greatest advantages in a factory.

8. Finally, when the machinery is started up this can be done without shock, electrical transmission operating as a veritable elastic buffer. In the same way, if the work calls for a sudden increase in power, the demand is communicated directly to the steam engine without affecting the speeds of the other machinery, while under the same conditions with a mechanical transmission a shock is produced which is felt throughout the whole system and affects the speed of all the various masses in movement. He mentions other advantages which to the practical man would seem of even greater importance than the foregoing. Transmitting shafts need no longer be absolutely parallel; they can even be put in all directions; and this permits of laying out the plan for the workshops, taking only into consideration good conditions of manufacture, without having to consider in advance the position which shall be given to the shafting.

Mr. Melotte supplies a most interesting study, for the technical details.

His statement as to the advantages is as follows:

1. It assures the complete independence of each main shaft.

2. It permits the stopping of one shaft without stopping the whole factory and without having to use devices which are expensive and which are always difficult to arrange for.

3. It permits of throwing a shaft which has been stopped, in again, which is not the case with most devices.

4. It permits of overloads as easily as any other system; thus the motor No. 5 in the Great Hall at the Herstal factory, the normal output of which is 16 H.P., ran for several days at 30 H.P. without inconvenience.

5. It gives more security, should there be a hitch in the transmission, for the motors are provided with an apparatus which cuts out the current automatically when the load runs above the limit. It permits of placing shafts in all the possible positions, without having to bother about making correspondence with those already up.

6. It is less cumbersome. The motor can be put in a corner; the conducting wires will follow the ceilings or the walls, or are carried underground, while mechanical transmissions take up considerable space with their shafts, bearings, pulleys and cables, and require a considerable outlay in repairs and oil.

7. It adapts itself with remarkable facility to any increase in the plant; two pieces of wire and the motor and all is done.

The installation at Herstal consisted of nine 16 H.P. motors, two 37-H.P. motors, and five motors varying from 21 H.P. to 3 H.P. Each of these, with the exception of two, one of which drove a pump and the other a ventilator, drove a line of shafting. The guaranteed efficiencies were 90 per cent. for the dynamo, 98 per cent. for the conductors, and an average of 87 per cent for the motors, giving a total efficiency of 76.6 per cent at the motor. While it may be perfectly true that in the particular case at Herstal this efficiency is superior to that which any one was willing to guarantee for mechanical transmission, it is obvious that it is inferior to the recorded efficiencies in some American machine shops. Professor Flather, in his work on "Dynamometers and Measurement of Power," gives a list of shops in which the per cent. lost in driving the shafting ranges from 15 to 50 per cent., leaving out an exceptional case of 80 per cent. It must be remembered that in comparing these shops with the Herstal factory the friction of the shafts driven by the motors is still to be accounted for in the latter.

It will be observed that many of the advantages enumerated by Messrs. Castermans and Melotte apply with even greater force to the third system—namely, that of the motor coupled directly to each tool. To these may be added the absence of overhead belting, unobstructed light and absolute independence of each machine.

On the other hand, by the multiplication of small motors the efficiency will be considerably reduced and the caretaking increased. So far as is known there is no machine shop equipped in this manner, unless, perhaps, that of the Crocker-Wheeler Company. A very near approach to it, however, so far as division of power is concerned, is to be found in the silk factory of Messrs. J. Forrest & Co., of St. Étienne, France, the description of which appeared in The American Engineer for December of last year. Here are employed 60 motors of 25 kilogrammetres, say ⅓ of a H.P., having an efficiency of 55 per cent., driving ribbon and velvet looms by cord transmission. There are also forty 75-kilogrammetre motors, each driving a loom by belt transmission. In addition to these there are five motors of power varying from 1 H.P. to 3 H.P., and two small motors from 10 to 25 kilogrammetres. The results at St. Étienne seem to be entirely satisfactory. It is obvious that the ultimate solution of the problem is a direct-coupled motor, although the first cost and the fear of an excessive amount of care taking stand in the way of its adoption.

It would seem that the advocates of electrical transmission have exercised themselves to prove a proposition somewhat doubtful in itself and of extremely small importance when taken in connection with the machine shop. Relative economy has a certain importance when power is used to drive machinery of unvarying productive capacity, such as looms, etc., or automatic machinery in general. In this case the workman must be educated to go at the pace set by the machine. In a machine shop, on the other hand, the amount of work of the same kind and quality turned out by different men varies very considerably. After all, the question which the engineer will ask is, Will electrical transmission enable me to turn out work at less cost? If each present will make a mental calculation of the ratio between the total amount paid in wages, interest, and depreciation on machinery, and the amount paid for motive power in his own factory, I think he will find that the motive power is not much more than 1 per cent. of the wages, etc. If it could be proved that the adoption of electrical transmission would increase the production of each man 1 per cent. only, this would compensate for doubling up the cost for motive power. On the other hand, if the introduction of electrical transmission would involve a loss of only 1 per cent. in the efficiency of the workman and machine, it is frivolous to insist upon the relative advantage of a difference between a transmission efficiency of 10 or 20 per cent., since there is an absolute loss equal to the total cost for motive power.

What shall it profit a man though he gain all these advantages enumerated, real and imaginary, and lose the sale of one machine because he cannot produce it cheaply enough?

DISCUSSION.

Professor Crocker: There is a great deal of difficulty in getting exact figures regarding this question, because so much depends on the particular conditions of each case, and any one who expects to get them will be disappointed. Then, too, even supposing that exact figures were available, there is another element that must be taken into consideration; it is as to whether the superintendent and workmen like the system, and this is one of those intangible factors that go very far toward determining the success or failure of such a plant. It is like that advantage of shop clearness cited by Mr. Richmond, and clearness has no coefficient of value. There is one point, however, where I must differ from the author. As I understood him, he said that in an ordinary machine shop the tools are used most of the time; but as far as my experience goes, and I am willing to make the statement applicable beyond the range of my own experience, there are very few shops where all the tools are used any considerable fraction of the time—in fact, I do not believe that the average load of work is more than 30 per cent. of the total capacity. Figures have been given by Mr. Lufkin, which show from 25 to 27 per cent. These may possibly be low, but I should think that 35 per cent. would be high. I mean by this an average taken year in and year out for the general run of shops. Now, when the shop is running light and only a few tools are operated, the electric system can be run at perfect efficiency nearly as well as if the whole shop were running; whereas any other system would be very uneconomical. It is thus especially adaptable to overtime work, which may be done with a small connected engine and dynamo of 5 H.P. or 10 H.P., while the same work done with the ordinary system would require the main engine to be operated. It may, therefore, be asserted that, where the work is variable, the electric system becomes especially advantageous—in fact, would seem to be almost essential to the best economy.

Mr. Oberlin Smith: It is probable that, in the matter of power, we can call it even between electricity and steam, with a balance in favor of the former on account of the intermittent running of the machines. At present the state of the art is crude, and better and more mechanical methods of transmitting power from the motor to the machine must be used, so that there is not so much waste in gearing, pulleys, shafting and belting as we now find in most designs. It, therefore, seems to me that the introduction of motors on individual machines depends on three things: one, the speed with which designers of motors and machine tools adapt them to each other; second, the first cost of the motors; and third, the expense of maintenance. At present it would seem that it is the first cost of the motor that is holding the work back, as expense of maintenance is comparatively little.

Mr. Fay: The question of first cost for an electric installation, which Mr. Smith has raised, depends on whether you direct connect a motor for the machine or whether you group—that is, the first cost is influenced by the question of direct connection or otherwise. We have for the installation where there is a motor for each machine a high first cost, where the motors are grouped at comparatively low first cost. The question of bringing the first cost down by manufacturing cheaper motors is, in my opinion, a matter not worthy of very serious consideration at this date. Electric companies would probably find it very difficult to pay dividends if they manufactured motors on the basis of copper at 12 cents a pound and iron at 3 cents a pound. There are other considerations. When the purchasers learn to select the motors promptly, buy them quickly, put the seller to as little trouble as possible, that will take off 40 or 50 per cent. of the cost, and that is one of the considerations. (*Laughter and applause.*) We come down to this question of a motor for a machine. We have given the matter serious consideration, and we have come to the conclusion, subject to change without notice, that it is not always proper or profitable to put a motor on every machine. We cannot imagine for a moment that the gear takes the place of the belt and does the work any better than a belt. It may be English, but it takes just as much power. Recognizing this fact, that a gear is a substitute for a belt—that is, oftentimes worse and not very often better—we have decided to build motors that would run at the speed you require without gear or belt, and we are building them to-day. But we do not believe the efficiency of a very small motor is high enough to pay for using it at all if we can possibly help it. To get down to figures, we have some 3-H.P. motors that will give us a commercial efficiency of 88 per cent., sometimes a little higher. A $\frac{1}{2}$-H.P. motor is a pretty good one at 60 per cent. Taking 15 or 20 per cent. loss out of the belt transmission and putting it into a motor will not increase the dividends at all; and it very frequently happens that the increased first cost of a very small motor, and the decreased efficiency which is the result of using it, will be a barrier which makes it more profitable to put several small machines of a kindred nature on one motor that has an appreciable efficiency. With that end in view we propose to have a motor, say 3 H.P., that runs at, say, 300 revolutions or 250 revolutions per minute, and extend the motor shaft out, connecting up to it one, two, three, four or five small drills or lathes or other things taking a fraction of a H.P. I have taken some measurements of that extension, and I find that 20 ft. of armature shaft extension might add a loss of $\frac{1}{10}$ H.P. We start out with an efficiency for this 3-H.P. motor, we will say, of 85 per cent.; if you want to feel very safe, decreasing that, with a loss of $\frac{1}{10}$ H.P., and then you have your total losses, when you have five or six or three or four kindred machines running from one motor. Now, comparing that with six $\frac{1}{2}$-H.P. motors at an efficiency of 50 or 60 per cent., we do not even need to guess at what the result will be. We therefore have concluded in a general way that direct connection is the proper thing if you can get a motor that will run so slow as to do away with the gear; or, if you cannot do this, the question of whether you use a single length of belt or gear will not effect the efficiency at all, and that is a mere matter of convenience. If a machine takes a small amount of power, as I say, we figure on putting three or four or five of them together—enough to make a load for a motor that has an appreciable efficiency. The question of speed is another matter. The use of rheostats for varying the speed is a piece of antiquity for which we have very little respect. We are aware of the fact that rheostats have been used for this purpose—would not swear to it but what they are used now. (*Laughter.*) I think I saw one to-day. But there is no need for them. In the past motors were designed so that if we undertook to weaken the field with a view to increase the speed, which would be the result of reactive effects of the armature, it brought us down to the sparking effect of the commutator, of which most of us know the result. We very soon have to send over to the manufacturers for a new commutator, and they say repairs are legitimate prey. In order that we would not have to use a rheostat because our commutator would wear out if we undertook to weaken the field in order to vary the speed, we built a new motor. That is the only remedy that we could find for it; and at the present time we have such a motor as will give us a difference in speed of 100 per cent. without any sparking whatever, and it is done by field commutation. That is the simplest way out of it. All that is necessary in order that speeds may be changed is to get a motor that will not spark when the field is weak. That involves the necessity of studying the design carefully, and that is what you pay the manufacturer for. We therefore are able to say to the gentlemen that the speed can be changed without this loss referred to. The cumbersome train of gears is unnecessary because we bring the motor speed down to meet the conditions direct. The first cost is a hopeless case. Motors do cost money. There is probably only one place that will permit of any reduction in the cost, and that is the question of general expense. General expense covers a multitude of sins of course; but one of the greatest sins against general expense is the terrific cost of getting people to buy motors.

Mr. Platt: It was very interesting to me to hear this evening of the developments in electric motors and motor driving, for I probably witnessed what was the first motor plant for transmission in existence. At least it is claimed in England to be the first. When I was at school I used to go down to South Wales, and in a colliery there they were driving electric pumps with a 3-H.P. Schuckert motor brought over from Germany especially for that purpose, as I believe there was no motor made in England at that time at all. That worked until 1883, and then they put in a Siemens motor and drove the same kind of a plant, and I saw that working three years ago, and it was in perfect condition. They had, of course, to renew the armature once or twice in about 12 years, and that was all. The old Schuckert worked for five or six years, and worked perfectly. So that one can go back even more than 15 years and find quite successful driving under ground in conditions not at all favorable for electric work, so much so that people five or six years ago would hardly have thought it possible. Four years ago I took up electrical transmission in England, and one of the first things I paid attention to was the driving of capstans for hauling trucks. We took motors and put them in a box with gearing and drove a capstan head. It was a compound wound motor, and the capstan head would run from 60 or 80 revolutions down to 40, and we had no trouble from sparking, and

the thing worked perfectly satisfactorily, and is working to-day just the same. The great trouble with it of course was that the only motors they were giving us were running at not less than 1,150 to 1,500 revolutions, and we had to gear them down, and that has been until the last 12 months I suppose, the most serious difficulty in electric transmission. Now that we are getting motors to run at 250 to 300 revolutions, we shall get a condition of things where mechanical engineers can probably take hold. From my experience in England, and from some I have had here, it seems to me that the points put forward by Mr. Fay are worthy of a good deal of consideration. One-H.P. motors and ½-H.P. motors have been spoken of for driving lathes. I do not think it is possible, when you come to consider the throwing off and on of the belt and the number of times you have to stop and start in running the lathe, that a motor can be stopped and started economically in that time, and I should think for some time to come we shall have to be content with the grouping of lathes and machines on a certain length of shafting. I question whether we shall find much saving from trying to drive on the machine. Take any large machine shop, extending over any area, and you will find that the great loss is always in transmission to long distances. It is the driving of the big lengths of shafts. I have a shop in view in which I did a good deal of work. It was a car works. We transmitted, I suppose, through 500 or 600 ft. of shafting. We had a rope-driven crane right at the end of that shaft; and they often have to drive the whole of the shafting of about 100 H.P. to drive this one crane. Right after that a case came up of driving a large band saw—an 8-ft. wheel for sawing large oak logs, that had to be put out in the middle of a yard. If I had had to carry shafting to it it would have cost in the neighborhood of a couple of thousand dollars. It was a long way from any steam. We would have had to take steam 400 or 500 ft. I put in a 60-H.P. motor for driving this band saw, and it has given perfect success. It is particularly adapted for that work, because you start in with a log 5 ft. at the base and going down to 2 ft. at the point, and the power was practically proportional to the work being done. It does seem to me now that in the condition that we are in, with slow-running motors we shall be able to do a great deal more in running our machine shops and getting a very successful working plant. The question of economy has been brought up. Within the last few weeks two authorities have spoken on the subject, one an electrical authority and the other a mechanical authority, both electrical men now—Mr. Crompton, who is the President of the Electrical Engineers in England, and Professor Kennedy, the late President, and who was a mechanical engineer. Kennedy says he does not think that there is any economy in electrical transmission for shop practice. Crompton says he thinks there is a great deal. Crompton is speaking as an electrical and Kennedy as a mechanical engineer. Mr. Richmond spoke of the cost of working being so much in proportion to the cost of driving the machine. I think that is a point that will decide a good many of the cases that will come up in electrical transmission. You will find that it is a question of how much you are going to save in economy of running and not in just the economy of power used.

Mr. Davis: There is a case in point that I am rather surprised Mr. Richmond has not mentioned. The Southwark Foundry & Machine Company, of Philadelphia, were obliged a few years ago to go into the electric driving of certain machines. They were building Porter-Allen engines. They had not any tools suitable to handle the bed plates. They had quite a number of portable tools, such as the slotters, and they were led to take these tools to the work because the work was too large to take to their machine, and they developed a very beautiful system of electric transmission. It was a portable system of electric transmission by which they took their machine to the work instead of taking the work to the machine. I think that is one of the branches of electric transmission that we have not heard mentioned to-night and which they have put to a very good practical use. I think their work has developed by means of those electric motors to an extent that would have been utterly impossible without them.

Mr. Henderson: There is another advantage that has not been mentioned this evening, and that is in arranging the roof trusses of a building; if we are designing a building and intend to put in shafting, it is customary to increase the trusses in the neighborhood of 10 per cent., and also arrange the trusses in even bays, so that they will support the shafting properly, and also to arrange the windows. If we do not have to pay any regard to this extra weight of the trusses, we can arrange the windows and trusses in a more satisfactory manner.

Professor Crocker: In reply to a question as to the best voltage to be used for shop practice, I should say that there is no particular point that would be best, but would recommend a medium voltage of from 250 to 300. This is neither very high nor very low. It is high enough so that the cost of the wires is small and low enough to be entirely safe, while the motors work well at this point, since the current on the commutator is not large enough to cause sparking. In the case of long distances, however, it might be necessary to raise the voltage, while for a very short distance 110 volts might be used. Another advantage would be that two incandescent lamps in series could be used on the same system, or a three-wire electric lighting system might be employed.

Mr. Ayer: I want to qualify Professor Crocker's statement about the voltage. I think that should receive a little further explanation. Two hundred and fifty volts, extending over a large area, of course would effect quite a saving, but for general practice in distributing through shops I should say that a 110 volt current was far preferable. The lower potential is quite a considerable factor in maintaining insulation. While it is true that a voltage of 250 is not dangerous to life under ordinary conditions, still with the dirt that is incidental to the transmission, and the maintenance of the line through the shops, which is liable to occur around your machinery, you get more or less difficulty in maintaining your machinery in good condition with a higher voltage than with a lower, and as a rule the extra cost of transmission would not amount to much when considering the advantage gained by the lower voltage—that is, the freedom from accidents. It is certainly a case where local conditions would have to govern.

Professor Crocker: That point, I think, is of considerable importance, and it might be well to consider it a moment. I admit that 110 volts in ordinary cases might be fully as good; but there is another point, and that is, the carbon brushes have hardly sufficient conductivity to operate for 110 volts. In other words, 110 volts necessitate twice the number of amperes that 220 volts require. Therefore the current capacity needed sometimes runs up to a point where carbon brushes are hardly sufficient, and the use of copper brushes in place of carbon would more than offset any other consideration. That is not an absolutely essential point. You could still use carbon brushes of considerable size; but it does enter as a question. We use 500 volts very extensively in railway practice and in power distribution, particularly in the West. In fact, power circuits in the West are universally 500 and even 600 volts, and they manage to maintain their insulation, and 220 volts is a mere bagatelle, as regards electrical pressure, compared with 500. So I think there would not be much difference with regard to the insulation. But for short distances the 110 volts would probably be the best; but as soon as the distances become at all great the amount of copper required would be quite serious.

The Chairman: I think it might be well to call attention to the fact that the discussion this evening has centred chiefly around the practice in machine shops, which was the limitation defined in the address of the evening; but at various times the debate has branched a little from that, and it would have been, perhaps, still more interesting if it might have included the practice in industrial establishments of other kinds. For example, it has been stated and accepted apparently that the percentage of time during which the machinery in the average machine shop is in use is very small; it was put as low as 30 per cent. of its total time. Now, in a vastly larger number of industries—industries employing a far larger number of hands than the typical machine shop which is in question—that percentage is very much larger, and approximates more nearly to 100. It certainly ranges as high as 60 and 70, and in some cases 80 and over 80 per cent. of the possible time, and there you will reach conditions so different as to make the treatment of this question of electrical distribution of power substantially different from what it may be under the conditions supposed in the case of machine shops. I think it is a fair conclusion for a listener to adopt this evening that the point which has been reached thus far in the development of electric motors, especially of the small sizes, both as to the first cost of the machines and as to the percentage of their efficiency in use, is such as to make it probably the best practice in the majority of cases to group machines together to an extent sufficient to utilize electric motors of reasonable size giving reasonable efficiency, and not to attempt wholly to eliminate shafting and belting. After all, the objective point of the manufacturer in all of these discussions is to obtain the highest efficiency of men and of machines, and all of these topics bear upon that question.

Professor Hutton: The committee have made arrangements that on the evening of March 13, which is the second Wednesday of March, the subject of the evening shall be the discussion of the rapid-transit problem in this and other large cities. Mr. W. B. Parsons, who is the Chief Engineer of the Rapid Transit Commission, will open the discussion, which will be illustrated by lantern slides.

Adjournment.

PRESSURE AND IMPULSE IN MOTIVE ENGINES.*

A LOOK INTO THE FUTURE.

When a man has spent 30 to 40 years engaged in what is called constructive engineering work, in an advanced environment, with personal powers of discerning tendencies, and understands contemporary practice, he is then in position to render the highest possible service to the world by forecasting the future.

To do this to the best advantage he must withdraw from the activities of practice and personal interest in a particular thing or branch, and must impartially survey the whole field, weighing, measuring, and comparing and considering what the trend is, and what the future will probably bring forth.

Such prognostication is of the very highest value. No other contribution to the world's industry can have more value, even in the intensely practical part. In fact, a great share of the highest human effort is devoted to prying into and endeavoring to find out what future wants will be, and what is likely to best supply these wants. It is the essence, so to speak, of both commerce and manufactures.

The most interesting and important part of such forecast relates to physical discovery in the technical arts, especially in implements, processes, and the control of natural elements, including motive power.

These remarks are suggested by a late letter received from Mr. Charles Brown, C.E., of Basel, Switzerland, containing some forecasts in respect to engineering matters.

Mr. Brown is one of the most eminent constructing engineers now living. This claim has authority far beyond the writer's opinions, but he can add the fact of for twenty years past watching with interest and profit every work and opinion emanating from this distinguished engineer. After a successful career of an average lifetime, in constructing work as diversified perhaps as has ever fallen to the lot of one engineer, bringing to bear thereon a remarkable natural ability coupled with education and training of the highest order, he has now turned back to look over the field passed through, and to draw from it conclusions that deal with the future.

I have no authority to introduce Mr. Brown's name here, and none to quote from his letters before referred to, but it seemed necessary in the present paper to shield myself behind the opinions of one whose views are entitled to much more weight than my own.

Some of Mr. Brown's views, as I gather them from one or two paragraphs in his last letter, and hinted at in previous communications of his, may be stated in the following propositions:

(1) The utilization of the force of fluids, elastic and non-elastic, will in the near future be mainly by impulse instead of pressure.

(2) The impulsion of fluids, elastic and inelastic, will be performed in future by the impulse of the same fluids, set in motion by rotation.

To render these propositions more plain, and connect them with familiar practice, they mean that steam engines, like water wheels and water engines, must abandon direct pressure and pistons for impulse wheels, and that piston pumps and blowing engines must give way to impulse apparatus.

This does not mean that a dynamic and constructive revolution is to take place, and that pumps and steam engines are to be at once changed from present methods of operation. No such proposition is intended, but that the future tendency is to be in that direction, or, as we may say, is in that direction now, to a greater degree than is commonly known or supposed. The proposition must also exclude special appliances, both for elastic and non-elastic fluids, and be confined to what may be called common pumps and motors.

I am not quoting Mr. Brown's words, or paraphrasing them, but am to some extent guessing at his opinions by inference.

Before speaking of the subject in its practical aspect, and as connected with modern engineering practice, some generalization may render it more clear.

Machinery to utilize the gravity of water in descending from a higher to a lower level; machinery to overcome the gravity of water and raise it from a lower to a higher level; and machinery to utilize the expansive force of water converted to steam, or, in other words, water-wheels, steam engines, and pumping machinery, with their attendant elements, constitute a large share of what a mechanical engineer is called upon to study and deal with at this day, and it is to these the propositions before named relate. I will not detain you by statistics of the amount of steam and water power in the world, or its relation to transportation, travel, commerce, manufactures, and even the social conditions of our times. This is too well understood to call for remark.

In the descent of water we have the choice of two methods for utilizing its gravity—pressure or impulse. The first represented by water-pressure engines, gravity or overshot wheels and pressure turbine wheels, such as those of Fourneyron, Jonval and the American types of inward discharge wheels, all operating by pressure caused by obstruction to flow, or, as we may say, receiving pressure directly. The second or impulse method, represented by the Atkins, Girard and Pelton wheels, operating from the impingement of jets set in motion by pressure, or, as we may say, by pressure in its second phase of spouting velocity.

The action of water in the case of enclosed or pressure turbines is not, I am aware, resolved mathematically, as stated above, but this rendering is near enough for the present purpose, which is to show how the two methods of pressure and impulse have in water-wheel practice been contending for 35 years past, dating from the first impulse wheels made by Messrs. Escher, Wyss & Co., of Zurich, Switzerland, about the year 1860. The principal facts of this rivalry will be again referred to.

In steam engines a similar struggle has begun between impulse and pressure. It is young yet, and lacks the history of water-wheel practice, but the future problem is now well before us in both its theoretical and practical aspects, but has not advanced to a place in popular knowledge that permits general discussion.

At this time all popular ideas, as well as nearly all practice, is confined to pressure steam engines of both the piston, or reciprocating, and the rotary kind, mainly the former, but all operating by direct pressure, and maintaining steam-close running joints, as around pistons. The construction and mode of operation is too familiar to require explanation.

In the other class of steam engines—the impulse kind—there is employed the efflux of steam impinging against vanes that move at about .055 of the velocity of the steam, or thereabout; for an average 500 ft. per second, or 30,000 ft. per minute, according to the steam pressure employed. In some cases discharged on the vanes at the initial or boiler pressure, in other cases expanded before impingement, down to atmospheric pressure, the effect being nearly the same, and as the mass, or ponderable weight of the fluid. The velocity is not diminished, and is even increased, at this lower pressure by means we need not inquire into here.

Here we have a strange analogy between the application of elastic and inelastic fluids, between water and steam, and in a change from pressure to impulse action. The same laws apply in respect to the relative velocity of motors, the method of application is nearly the same; in fact, impulse water-wheels have in some cases been driven by steam.

The main distinction is in the respective velocities of efflux and consequent speed of the motors. For water we have $V = \sqrt{2\,g\,H}$, and for steam $V = 60\ \sqrt{T + 460}$, both in feet per second, or comparing for a pressure of 100 lbs. to an inch as eight to one. At this pressure a steam-driven wheel to operate economically would have to attain, as before remarked, a speed of about 500 ft. per second, 30,000 ft., or more than 5.5 miles a minute.

Before referring to the tendencies in present practice, and considering what the future may bring forth, I will point out that a first conclusion will be that all these things are amenable to computation, and can be solved mathematically. This is unfortunately not the case. Some of the conditions, and even the dynamic results, may be thus arrived at, and have been in the case of Parsons' impulse steam engines, also Dr. De Laval's, but the main problems are of a constructive nature, pertaining to the maintenance of high velocities, balancing, lubrication and the elements of transmission.

Still it must be admitted that but little progress can be made without the aid of computation in verifying and explaining results in so far as forces and resistances, but, as remarked, the chief problem lies in that branch of engineering we call constructive. For example, a theoretical steam engine would be one of the rotary type, sustaining direct pressure, and moving at velocities not at all attainable in such engines, even if they were a possible machine on other grounds, which they are not.

The strange proportions of parts would never have been resolved as they are found in practice either by inference or computation, but being found, then new light is added by theory; definite rules are arrived at, the direction and measure of inherent forces are made plain, the thermal conditions

* A paper read before the Technical Society of the Pacific Coast, by John Richards, January 4, 1895. Reprinted by permission of the Society.

are explained ; but first and mainly must come the constructive idea or design qualified by working conditions so obscure as to defy human wisdom until tentatively developed by long and tedious experiments dealt with empirically, often blindly, and no small share arrived at by accident. This has been the common course in the past, and is now to a great extent the course followed, but in some instances progress has been the other way, not from construction, use and experiment, but in attempting to supply mechanism to accomplish certain computed results.

Pressure and impulse steam engines furnish two notable examples of these two methods of development. The first were a constructive and experimental problem throughout three-fourths of their history, before the study of thermal laws became a part of steam engineering. Then by both computation and a higher constructive skill the advance during 20 years past has produced our modern types, approaching nearly to ultimate efficiency for the pressure system as it now exists. The course of impulse-engine development is different. It starts with all the aids that have attended the final work on pressure engines, but on the whole the system or method has in 10 years made nearly as much progress as the pressure or piston type did in a century ; that is, from a steam consumption of 48 lbs. per H.P. down to 14.5 lbs., or high efficiency for a modern expanding engine of the piston type. This matter is mentioned as one factor to be taken into account in forecasting the future and interpreting signs that increase from month to month.

Reverting now to the practical part, and first to water wheels, we can easily follow the advance made in the impulse type. The first discovery and proposition of this method, so far as I can trace it, originated with Mr. Jearum Atkins, an American, now in his old age an inmate of the Mechanics' Home, in Philadelphia. He presented his invention of open or impulse turbine wheels in the American Patent Office in 1853, where it could not be understood, and a patent was refused. He at that time filed in the office a complete analysis of the theory upon which these wheels operate, clear, concise, and to-day one of the most lucid descriptions that can be referred to.

In 1875, 22 years later, a patent was granted to him for the same invention ; but before this time—about 1860 – impulse turbine wheels had been taken up by some of the foremost engineers in Europe, and had become a standard type in France and Switzerland. At the present time, and for 15 years past, no other form of water-wheels have been thought of there, or in other European countries, for heads exceeding 50 ft.

The practice is very uniform all over Europe, and the number of impulse wheels made must exceed pressure turbines three to one. The great wheels at Niagara are a modification of the Girard or impulse system, more nearly impulse than pressure wheels, the plans being supplied by Messrs. Faesch & Picard, of Geneva, Switzerland, who were among the early makers of Girard wheels.

On this coast I need hardly say that tangential wheels, a purely impulse type, have displaced pressure turbines for all except low heads, with gain in efficiency, a saving in first cost and in maintenance. The impulse method has in fact been successful in all cases of competition up to a limitation by the volume of water that for constructive reasons renders the system inapplicable for low heads, and when wheels require to be submerged.

The change from pressure to impulse in water-wheels is, however, by no means so great a change as that between pressure and impulse steam engines. The initial velocity of water, or of wheels driven by this element, is the same in both cases, but with steam the initial velocity is changed, as we have seen, as fifty or sixty to one, giving rise to new and extraordinary differences. To make these more plain, I will again enumerate with more detail the conditions of operating with pressure or piston engines.

The weight and space occupied by motive engines of all kinds are, as a rule, inversely as the velocity of the "actuating parts," and by such a rule pressure engines should be fifty times the weight of impulse engines. The running joints or bearings for pistons, valve-rods, valves, guides, connections, and so on, consuming from 6 to 10 per cent. of the developed power in piston engines, are nearly avoided in the impulse type, but are to some extent, not known, balanced with losses by air friction on the impulse wheels. The elements of transmission between the piston and crank shaft have at all points throughout to withstand the full measure of strain imparted to the crank-pin, not uniformly, but in a series of waves, to so call it, consequently these elements are about five times as heavy and expensive as when the initial movement corresponds to .055 that of the flow of steam, or is eight times greater. The change also simplifies such gearing.

Vibration, due to intermittent stress and reciprocating parts, is a serious objection and impediment in the pressure system. It calls for ponderous fastenings and foundations that, with lavish plans and material, especially in vessels, is only partially successful.

Fly-wheels have to be provided to equalize the variable turning moments in all land engines. This function is supplied in vessels by paddle-wheels, screws and multiple engines, but a fly-wheel of some kind is an essential part of an ordinary piston engine.

We have then in this case a motor moving at 8 to 10 ft. a second, impelled by a fluid whose normal flow is 800 to 900 ft. a second, fifty times the weight and ten times the space occupied that would be required if the steam could be directly applied. There is, however, one difference that must be kept in mind : that in engines driven by the impulse of steam a certain speed must be maintained, while in piston engines this is variable in any degree.

For most purposes this latter feature is not important, but is indispensable for traction, and we need not look for change in that branch of steam machinery. The same fault would in some degree apply in navigation where variable speed is necessary, as in the case of boats making frequent landings, but not for ocean service.

This difficulty in impulse engines arises from the fact that the flow of steam follows a different law from that of liquids, and is computed as a function of temperature, instead of pressure or head, varying only 35 ft. a second between 25 and 100 lbs. pressure, and only 10 ft. a second between 100 and 150 lbs. per in.; consequently speed cannot be controlled by volume.

But outside of all uses requiring variable speed there is left a much wider field for impulse engines, and considering the objections to the pressure or piston system before pointed out, we cannot wonder that men learned in these matters should set about finding out some escape from such sacrifices made to mechanical expediency. I am not able to name but a few of the eminent engineers who have considered and are engaged in developing the impulse system for steam engines.

First may be named Dr. De Laval, of Stockholm, Sweden, inventor of the centrifugal cream separators, who to impel these high-speed machines conceived the idea of a steam-driven impulse wheel, operating by the direct efflux of a jet applied on vanes. This, as we believe, was about 10 years ago. The object was not efficiency or novelty, but a high initial rate of rotation to avoid transmission gearing. The result was so remarkable as to lead on to further experiments and results until a steam consumption as low as 40 lbs. per H.P. per hour was attained.

Then the matter began to attract attention, and the Hon. C. A. Parsons began, in England, a series of exhaustive experiments, connected with careful computations of the thermal and dynamic conditions attending on the impulse method, and now at the end of less than ten years he has removed modern compound piston steam engines in the city of London, and replaced them with steam turbines or impulse engines. This was done in one of the stations erected only a short time ago, and, as Mr. Brown remarks in his letter before referred to, "is a most significant fact." It is more than a year since the editior of *Engineering*—a high authority—conceded that the impulse steam engine had attained the same efficiency as a two-cylinder compound piston engine.

Able engineers all over Europe have this problem in hand now, and if, as Mr. Brown writes, steam consumption has been reduced to 6.5 kilograms, or 14.5 lbs. per H.P. per hour, the thermal problem is done—that is, the efficiency has overtaken the pressure engine ; and now remains a development of various constructive problems that are almost sure to be rapidly worked out.

The speed of impulse engines follows the same law that applies to all motors driven by the efflux of fluids, the residual velocity, or, as we may say, the residual "rest," because there should be no velocity in the spent steam, is a resultant of two components, the movement of the fluid and that of the motor, the former being reversed in its course, and the relative speeds of the steam and the vanes or buckets being as 100 to 55. This rule produced in the first engines of De Laval and Parsons from 20,000 to 30,000 revolutions per minute. Five years of constructive effort has reduced these enormous velocities of rotation to one-third as much, and to a point where direct connection to the armatures of electrical dynamos is possible, and the required gearing of transmission is brought well within the resources of modern practice.

The conditions of operation in pressure or piston engines have been in part pointed out, and, as said, disclose the incentives that have led to the impulse method. Ultimate efficiency is not the object. This cannot in the nature of things vary

much between pressure and impulse. The force of efflux in fluids is equal to their gravity multiplied into their velocity, less the friction of orifices, and apparatus that will utilize the impinging force in the same degree that pressure is utilized by pistons will be equally efficient, other things being equal; so the objects to be attained by the impulse method for steam engines lies in another direction.

It will be revolutionary to institute complete comparison, and unfair in the present state of the impulse method, only ten years old, dating from the De Laval experiments. Steam consumption has fallen from 48 lbs. to 14.5 lbs. in that time, and from being a curious experiment the impulse engine has thrust itself in among its venerable competitors, not in obscure corners, but in high places. The electrical generators on the two greatest transatlantic steamers are driven by impulse engines, supplied by Mr. Parsons about four years ago. There are many other cases that cannot be called to mind at this time.

Other inventions of equal extent rise in these times, pass into the industrial field and soon disappear in the whirl of progress and change that characterizes our age and time, but here is one of different nature and portent.

The application of motive fluids by impulse instead of direct pressure, that came about almost insensibly in water, means a wide revolution in steam, one that will not only modify constructively and economically nearly all that pertains to steam power, but will widen the field of application to hundreds of purposes not now thought of.

Mr. Brown informs me that he is considering the application of impulse engines to traction purposes, but has naturally met with the impediment of variable speed, almost the only fundamental virtue inherent in the piston engine, and, as before said, confined mainly to this very case, so that he has attacked the exaggerated end of the problem, and will most likely abandon the scheme.

One other feature of impulse engines remains to be noticed. Expansion to the fullest degree must be a characteristic of any economical steam engine. This Mr. Parsons provided for at first in nine stages, and to transfer from one stage to the next involved a principal feature of objection to pressure engines, that of maintaining steam-tight running joints, not actual contact between surfaces in this case, but joints of such precision that, while not in contact, no considerable leak could pass through them.

This calls for an accuracy of work that cannot be attained with ordinary implements and by ordinary skill, but the De Laval engine avoids all this by a single application of the steam, first expanding it to the pressure of the atmosphere, and converting the expansive force into velocity.

This is in my opinion the key-note to the whole system, because engines thus made require no close running joints, and are simple in all their elements, down to the reducing gearing, and this, as now constructed, seems to operate without difficulty.

For eight years I have urged on all possible occasions the attention of engineers on this coast to impulse steam engines, and their importance for special if not general purposes. These propositions have been treated, like perhaps the present paper may be, as a visionary matter, but however this may turn out, I am getting into very respectable company, and feel encouraged accordingly, hoping even to see at some future time an engine of 100 H.P. wheeled on a hand-barrow, a quiet, undemonstrative little machine that can be set in some corner out of the way on a common floor; also to see power distributed by impulse air engines over wide districts without much loss in transmission, without heat, danger, or the complication of electrical apparatus even.

This is, perhaps, enough for one occasion, and all that it is safe to say; but having the floor, I may as well go on and shock the engineering proprieties with the second proposition, relating to impulse, laid down at the beginning. It was as follows:

"The impulsion of fluids, elastic and non-elastic, will in future be performed by impulse derived from the momentum of rotation."

This proposition, almost wholly new to me, comes in a rough pen sketch and some explanation by Mr. Brown of what he calls the centrifugal pump of the late Emile Bourdon, an engineer whose name will be familiar to most of those present by reason of his other inventions relating to fluid action.

Fourteen years ago, when I undertook the construction of centrifugal pumps here in San Francisco, I was informed by people whose opinions were certainly to be considered that pumps of that kind would not operate against heads exceeding 40 ft., and they proved it, too, by rules, showing that an increase of resistances with head fixed a commercial, if not practicable limit at that pressure. Combining two pumps, I found their force in series was multiplied accordingly, and a pump to operate against a head of 80 ft. was made and operated successfully.

Single pumps have since then been made to raise water 160 ft. without encountering the theoretical resistances commonly set forth in authorities, and I have the boldness to believe that the theories applied to these pumps are wrong, and that what we call the centrifugal method of pumping has no such limits as have been fixed by computation. I presented in a previous paper before this Society the enormous increase of capacity, and a corresponding decrease in cost, of continuous flow pumps, and came near some predictions that, if the paper were to be written now, would form a portion of it.

Heretofore we have operated in one line of construction, or method, for generating what we call centrifugal force, or a force derived by rotation for impelling fluids; but, if instead of centrifugal force, we consider the momentum of revolution, and deliver this momentum impulsively to the performance of work, we are carried into a new field, and the limitations of the centrifugal pumping will disappear, theoretically at least.

If a body of water is set in revolution by being dragged over large frictional areas by an impeller whose velocity at different radii cannot conform to that of the water, we cannot expect to impart to the water a very large proportion of the original energy, or driving power, employed to set the water in motion; but if the water is gradually set in rotation, almost without friction or retarding influence, except its inertia, that water applied impulsively should give out again in useful effect within a few per cent. of the original energy or power. To do this the water should not be whirled around in a stationary vessel or case, but in one revolving at the rate desired for the water to attain, and the impulsive effect taken off, so to speak, by impingement on the fluid to be raised or impelled.

It is, perhaps, inexpedient and unfair to bring to the Society's notice a matter so little supported by tangible data at this time; but knowing that some of our members are now engaged in hydraulic problems relating to the impulsion of fluids without the losses of intermittent motion, and as the Bourdon pump is an impulse machine, it cannot be passed by. The proposition involves both the generation and application of the pumping or impelling force, and there is, of course, no direct analogy to steam-engines and water-wheels that draw from an accumulated store of energy.

The Bourdon scheme involves a translation, it may be called, of the energy as well as its application by impulsive effect.

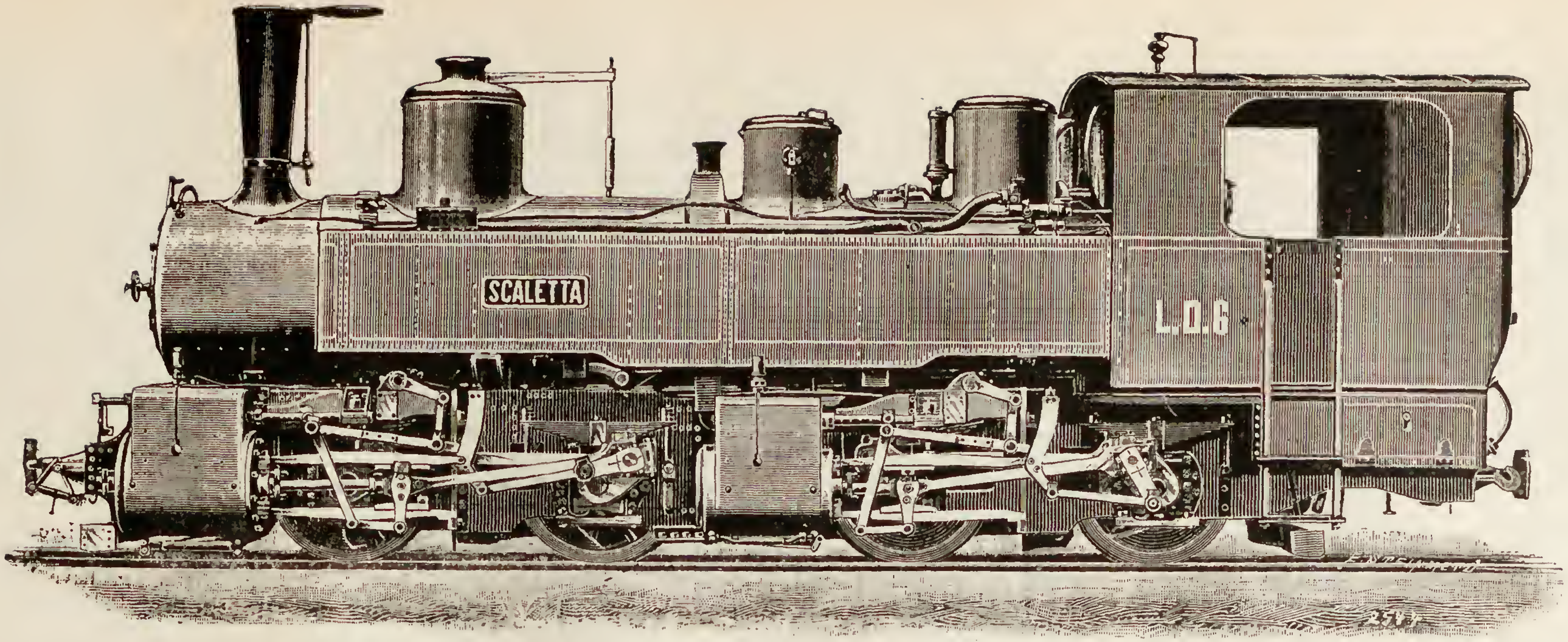
Suppose that a cylindrical vessel like a centrifugal drying machine, having inward projecting vanes around its interior periphery, is filled with water, and set in revolution up to a velocity of 80 ft. per second at the interior tips of the vanes. The water would then be moving at a rate the same as that produced by a head of 100 ft., and if this water could be diverted tangentially, and directly applied to the propulsion of other water to be raised or impelled, the losses would be inconsiderable. To take off this revolving water tangentially a discharge nozzle has to be introduced inside of the revolving chamber. This discharge pipe would, of course, obstruct or prevent rotation of the water in the zone occupied, creating a frictional area equal to the width of the revolving chamber multiplied by a circle touching the end of the discharge pipe. This frictional area is not more than a third what is encountered in a common centrifugal pump, and is that of viscosity principally.

This indicates in words the experiments being tried by Mr. Brown, who, as I understand, proposes velocities far beyond precedent, or possible, with a common centrifugal pump. The same method can be applied to air or any elastic fluid the same as water.

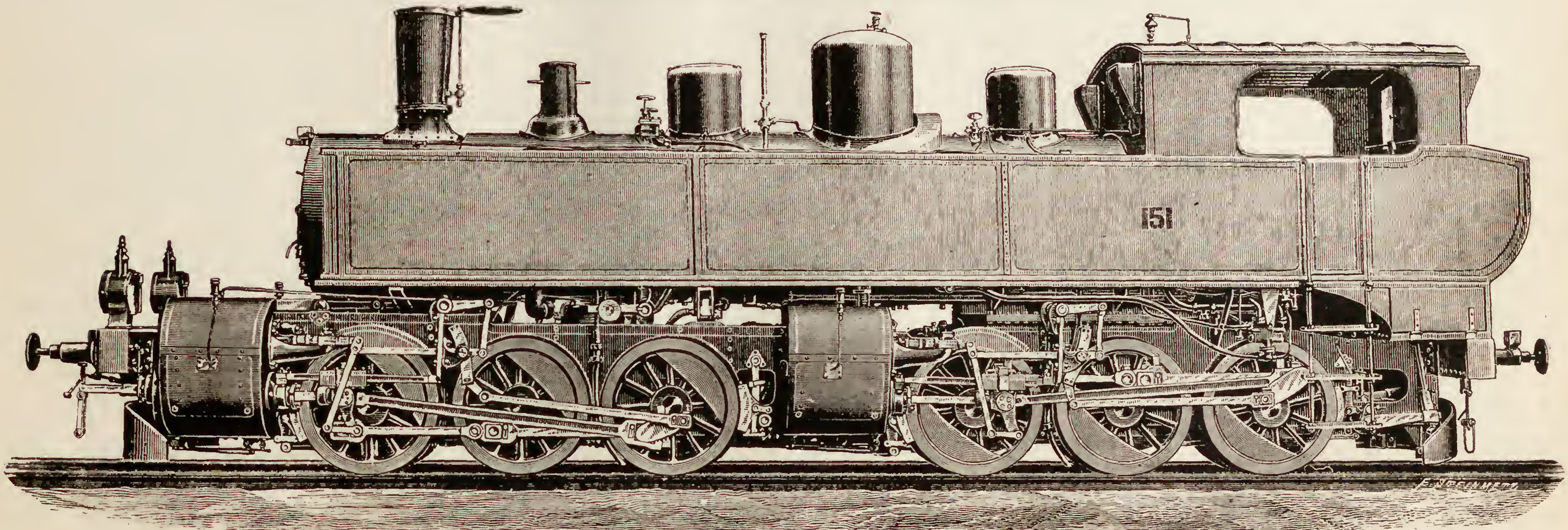
There may be present members who are familiar with the experiments and views of M. Bourdon. I will not pursue the matter further now, but with consent may at some future time lay before the Society some results of experiments now going on that may modify present views of the impulse method of translating energy.

ENGINES FOR THE ST. GOTHARD RAILWAY.

In a recently published table *Engineering* gives the lengths and weights with the fuel consumption of the locomotives that are in use on the St. Gothard Railway, in which it is shown that the weight of the goods engines has gradually increased from 56 to 87 tons, and that of the passenger engines from 56 to 100 tons, the greatest load on one pair of wheels being 16 tons. The heaviest engines of both classes are the two types lately acquired—viz., the 87-ton duplex-compound Mallet engine for heavy goods traffic on the mountain sections,



COMPOUND DUPLEX TANK LOCOMOTIVE; LANDQUART-DAVOS RAILWAY.



ST. GOTHARD 87-TON DUPLEX MALLET COMPOUND FREIGHT LOCOMOTIVE, BUILT AT THE MAFFEI WORKS, MUNICH.

and the 100-ton three and four-compound engines for express passenger service over the whole line. Of these two types, the 87-ton Mallet engine, built in 1891 by the Maffei Works of Munich, has now been running for two years, while the 100-ton compound express engines, built at the Swiss Locomotive Works at Winterthur, have only been recently put on the line.

The following are the leading dimensions of the duplex-compound 87-ton engine which is illustrated on page 120 :

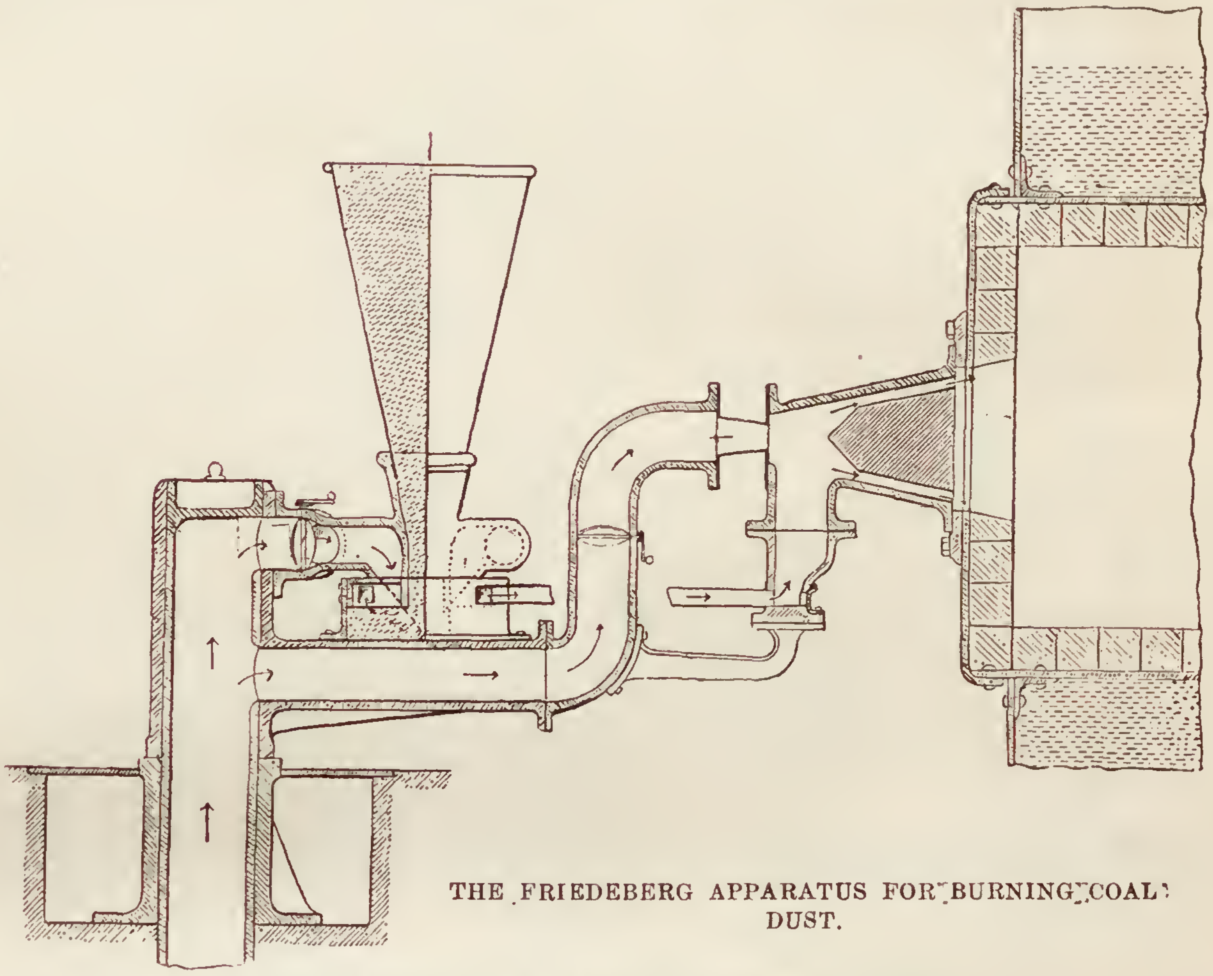
Diameter of high-pressure cylinders	15.7 in.
" " low " "	22.8 in.
Stroke	25.2 in.
Pressure in boiler	177 lbs. per sq. in.
Diameter of wheels	4 ft.
Total heating surface	1,660 sq. ft.
Grate area	23.6 sq. ft.
Weight empty	69.4 tons.
Fuel	4.3 tons.
Water in tank and boiler	13.5 tons.
Total weight in working order	87.2 tons.

At 50 per cent. admission, the tractive power of the engine is 9 tons. The power developed at a speed of 12.5 miles per hour on the maximum (2.7 per cent.) grade with a load of 200 tons, and under favorable conditions of adhesion —viz., with a coefficient of traction of 11 lbs. per ton, works out at 760 H.P. The average consumption of fuel is 67 lbs. per mile, but on the steepest grades it is no less than 1,666 lbs. per hour, or close upon 160 lbs. per mile. This is 2.5 times the average consumption of the engine and 3.5 times that of the average consumption of the other engines. The consumption of grease and oil of this engine is as much as 0.35 lb. per mile run, or nearly twice as much as the average of the other engines, which is 0.18 lb. Again, its tractive power is only about one-tenth of its weight, and altogether the internal resistances of the engine are so enormous that its working results cannot be described as favorable. On the other hand, smaller engines of this type —viz., eight-wheeled, weighing only 41 tons full, and giving a tractive power of 6 tons, or one-seventh, have given very good results on the metre gauge railway from Landquart to Davos. The average gradient of that line is 2, the maximum 4.5 per cent., and the average consumption of fuel of the compound engines, of which an illustration is given with the other engine on page 120, is only 38 lbs. per mile.

THE FRIEDEBERG APPARATUS FOR BURNING COAL DUST.

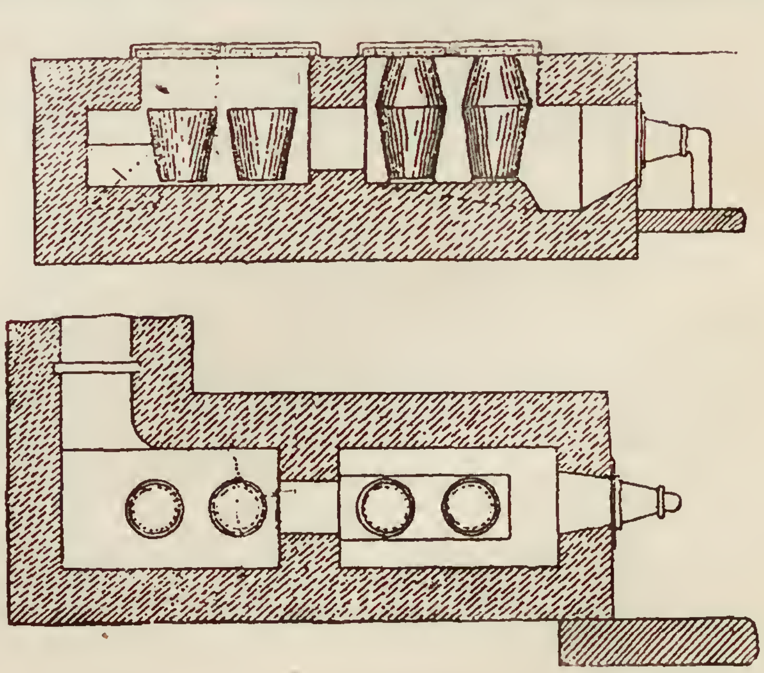
The apparatus which we are about to describe is the invention of Herr Friedeberg, and has been introduced in Germany by the Allgemeine Kohlenstaubfeuerung Actiengesellschaft, Patente Friedeberg of Berlin. Arrangements of the kind are not exactly new, but the present one is an improvement in that the coal dust is not fed into the furnace by means of revolving or swinging grates, but by means of an air blast. Referring to the illustrations, fig. 1 shows a section through the arrangement. The vertical blast-pipe, seen to the left, is closed at the top and provided on one side with two round openings. Around this is arranged a revolving casing, fitted with two pipes in such a position that when the apparatus is ready to be put in operation, and during operation, the pipes coincide with the openings just referred to. When it is desired to cut off the blast and stop feeding the furnace, the *whole* arrangement is revolved around the vertical blast pipe, so bringing the pipes against the solid wall of this instead of opposite the openings of the same. The hopper terminates in a box, in the upper half of which are worked two pockets open at the bottom. The upper pipes from the vertical blast-pipe are led into the box by nozzles around the bottom of the hopper. These nozzles are so arranged that the blast moves and blows away the coal dust along the square passages shown, to the delivery pipe. Any small pieces of coal, etc., in the coal dust fall to the bottom of this delivery pipe, from which they may be emptied out as occasion arises by means of a movable cover. Underneath the boxes and hopper supporting them, but not in communication with them, runs a larger horizontal blast-pipe, terminating in the central vertical pipe. This, again, bends horizontally and terminates in a nozzle opening into the base of the conical chamber seen on the right of the illustration (fig. 1). Both the upper blast-pipe and the lower or secondary one are provided with throttle-valves, by means of which the pressure of the air-blast is regulated. The mixed coal dust and air now encounters the full blast from the large lower pipe, which drives it into the conical space between the sides of the hollow cone and the solid core seen to the right. Thus an intimate mixture of air and coal dust is continuously and regularly fed into the furnace.

To create the air blast a Root's blower or other arrangement of the kind may be used, the power required being from ½ to 1½ H.P., according to the size of the apparatus and to the quantity of coal dust to be fed to the furnace. Herr Friedeberg, the inventor, states that in order to burn 1 lb. of coal dust only 11 lbs. to 12 lbs. of air are necessary, while so much as 20 lbs. are normally required. The extra cost entailed by the air blast is therefore only small, and is more than covered by the



THE FRIEDEBERG APPARATUS FOR BURNING COAL DUST.

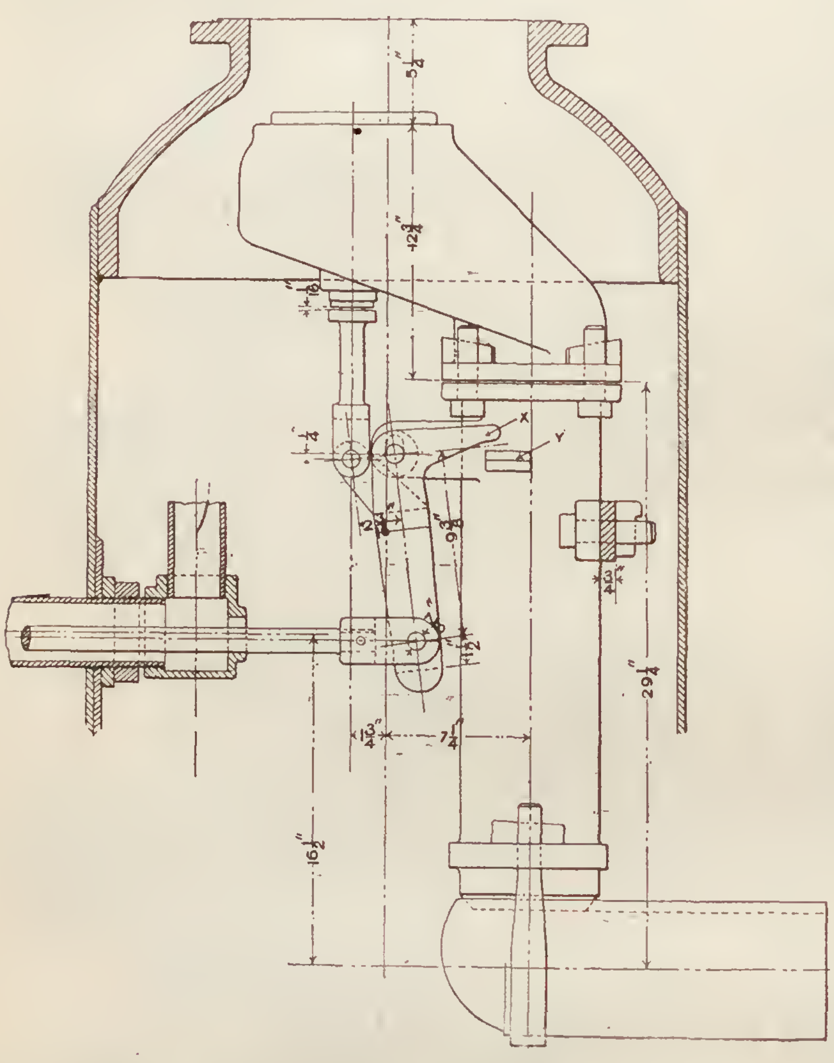
Fig. 1.—Sectional View of Apparatus Fitted to Boiler.



Figs. 2 and 3.—Sectional Elevation and Plan.

more perfect combustion of the fuel obtained by its use. The combustion of the coal dust is so regular and complete that the walls of the fire-box may be quickly brought to a white heat. Up to the present two sizes of this apparatus have been made—one capable of feeding into the furnace from 11 lbs. to 12 lbs., the other from 22 lbs. to 330 lbs. of coal dust per hour. Arrangements are provided for regulating the feeding of the coal dust to the exact quantity required by means of the air-blast. It is claimed that whatever be the pressure of the air-blast, the delivery of the coal dust is perfectly regular, and that no smoke whatever arises from its combustion. The fineness of the coal dust used depends on the kind of coal; the maximum is that passed through a 0.25-mm. mesh screen, the best results being, however, obtained with dust passed through a 0.1 mm. mesh screen. A certain degree of moisture may also be given to the air-blast, according to the kind of fuel used.

One of the first installations of this coal dust burning arrangement was carried out in the early part of this year at the works of Messrs. Arndt Bros., in Berlin. This is a small-size apparatus, and has been working ever since, giving entire satisfaction. Since then two sets of a larger size have been fitted to a Cornish boiler, having two furnaces, at the glass works of Messrs. Ebert & Neumann, at Stralau, near Berlin, and these are still in successful operation. The latter installation



THROTTLE VALVE, PENNSYLVANIA RAILROAD.

is shown in fig. 1 in our issue of the 12th inst. In the first example quoted, the boiler is of the Paucksch tubular type working up to 16 H.P., at a pressure of 105 lbs. per square inch. It supplies steam to a 12-H.P. engine, 715 lbs. of coal dust being consumed on an average per 24 hours, equal to about 4.95 lbs. of fuel per H.P. per hour, including the coal consumed at the start for heating up the boiler. In the second case, the boiler has a heating surface of 90½ square metres, and works at a pressure of 90 lbs. per square inch. It supplies steam to a 50-H.P. engine. In this case ground English steam smalls are used, the consumption per 24 hours amounting to 5,610 lbs. The economy in fuel in the latter case is shown by the statement that the consumption of fuel—of a much better quality than at present—before the arrangement was fitted up, was about 6,930 lbs.

It is not only in connection with the firing of steam boilers that the new arrangement may be adopted with success. It would appear to have a bright future as regards the heating of smelting furnaces in place of the present system of using expensive foundry coke. In fact, a furnace has been constructed for the heating of melting-pots, to the front of which this apparatus has been fitted in place of the so-called French crucible furnace (see figs. 2 and 3). The hearth of the furnace is 9 ft. 10 in. long, the height corresponding to the size of the crucibles or melting-pots. The furnace, as will be seen, is divided into two parts, the front portion serving for the smelting of the metal, while the back part serves to give the crucibles a preliminary heating up. In a furnace of this kind 110 lbs. of copper have been melted down in 45 minutes, including the time occupied in heating up the furnace. The quantity of coal dust consumed per kilogram (2.2 lbs.) of metal was found to be about 13⅓ oz., as against, in the old system, from 2⅕ lbs. to 3¾ lbs. of foundry coke. Holes are provided in the top of the furnace, fitted, of course, with covers, so that without any interruption in the heating operation, and with only a slight fall in the temperature, one crucible may be taken out and immediately replaced by another one previously slightly heated, smelting operations being thus carried on with more dispatch than formerly. A careful estimate has been made of the cost of the foundry coke previously used and the coal dust now employed, and even allowing for an equal consumption of the two fuels, it is found that there is a saving in cost of over 50 per cent. in favor of coal dust. As a matter of fact, the quantity consumed of the latter is only about one-third that of the foundry coke used, so that the economy is even greater than 50 per cent. It is further claimed that, by the use of Friedeberg's apparatus, the life of the crucibles is lengthened, owing to their not coming into contact with the coke, etc., in the furnace, and that the whole operation is attended with much more cleanliness than has hitherto been the case, while a higher temperature may be attained with the coal dust than with coke.—*Industries and Iron.*

THROTTLE VALVE, PENNSYLVANIA RAILROAD.

Mr. Vogt, the Mechanical Engineer of the Pennsylvania Railroad, has recently designed a new form of throttle valve that is not only exceedingly simple in its construction, but very effective in its operation. There have been innumerable devices to overcome the closing pressure that is exerted on the common form of valve, due to the inequality of the areas of the two seats, but up to the present none of them have been altogether satisfactory on account of the complication that they involve in the attachments or the extra care and expense demanded in the grinding in of extra seats and the making of extra valves. The device that we illustrate is so simple that it seems strange that it has not been brought out earlier. The valve itself is the same as that used on the Pennsylvania and other railroads, and the device consists in giving the engineer a greater opening leverage at the instant of starting the valve than that which he has after it has been opened a little and the steam has entered the dry pipe, and balanced the valve. The valve stem extends down from the valve and takes hold of the bell crank in the usual way. It will be noticed, however, that the arm of the bell crank that is attached to this stem is very short, and that the lower arm to which the rod from the lever is fastened is long. This arrangement gives the engineer a very powerful purchase on the valve, and he is thus enabled to start it with comparative ease. The pin upon which the bell-crank turns passes through a slotted hole in the bracket on the dry-pipe, as shown by the dotted lines on the engraving, and when the valve is closed it is held down to the bottom of this slot by the pressure on the valve. The same thing holds true while the valve is being opened until the back projection X of the bell-crank comes down and in contact with the bracket Y. Then the leverage instantly changes, and the valve opens more rapidly, while the pin upon which the bell-crank at first turned, rises in the slotted hole already alluded to. It will thus be seen that when considerable power for the starting of the valve is necessary it is available, and that as soon as the valve is opened and thoroughly balanced it opens rapidly and easily.

MEASURES TO PREVENT STRIKES.

The New York State Board of Mediation and Arbitration were ordered by the Legislature to make an investigation of the trolley strike in Brooklyn, and report thereon, with a view to the recommendation of such measures as may prevent such occurrences in future. The report has recently been submitted to the Legislature, and says:

"The additional inquiry failed to throw any new light upon the cause of the strike, which, in a word, was the direct consequence of the inability of the officers of the roads and the executive officers of the employés embraced in District Assembly No. 75, Knights of Labor, to renew for 1895 the contract of 1894 between them, with certain amendments proposed by the latter. This disagreement of the employers and employés, however, was but an apparent or superficial cause—an effect rather than a cause. The primary cause of this Brooklyn strike and of all kindred strikes is to be found in the fact that the Legislature, in creating railroad corporations and vesting in them the public function of transporting persons and property of the people, has neglected to make necessary provisions for a stable and efficient service of operating forces upon the lines to subserve the end for which they were given breath of life and clothed with the State's power of eminent domain.

"Any remedial legislation to be effective should have prevention for its objective point. The interruption of operation of a railroad in its service to the people for which its corporate owner was created, by reason of a controversy or dispute between the company and the operating forces, or strike of the latter, should be made impossible. The measure recommended by this Board is one that would bind alike in mutual obligations both employer and employé, and in outline is as follows:

"1. Declare the service of railroad corporations created by the State a public service.

"2. Entrance into such service to be by agreement for a definite period, upon satisfactory examination as to mental and physical qualifications.

"3. Resignation or dismissal from such service for ordinary cause to be permitted, to be stated in writing and filed with some designated authority, and to take effect after the lapse of a reasonable and fixed period, with proviso for summary resignation or dismissal for extraordinary cause, to be stated and filed in like manner.

"4. Wages to be established at the time of entry, and changed only by mutual agreement or decision by arbitration of a Board chosen by the company and employés, or by a State Board, or through the action of both the latter serving as an appellate body. Other differences that may arise to be settled in like manner.

"5. Promotions to be made upon a system that may be devised and agreed upon by both parties, with the aid of a State Board, if necessary.

"6. Any combination of two or more persons to embarrass or prevent the operation of a railroad in the service of the people a misdemeanor; and any obstruction of or violence toward a railroad serving the public, endangering the safety of life and property, a felony, with punishment of adequate severity.

"7. Establishment of a beneficiary fund for the relief of employés disabled by sickness or accident and for the relief of their families in case of death, as is done upon the lines of a number of railroad corporations in other States.

"8. Membership in a labor union shall not be used as a bar against the employment of competent workmen by a railroad corporation created by the State.

"All to the end of a discharge of mutual obligation of railroad corporations and employés, the enjoyment of mutual benefits, and the securement of a permanent and satisfactory service to the people, who have a right to it and a right to use every power necessary to obtain it.

"It is confidently believed that a law enacted on the lines of the measures above suggested would insure relief and justice to all.

"A point of very great importance in the operation of railroads, and especially of electric street railways in the congested streets of cities, is that of sight and hearing in motormen and conductors. The trolley roads have been in operation in Brooklyn between two and three years, and during that period more than 600 accidents have been reported, and it would probably be conservative to add 150 to that number. The number of people killed up to the first of the year 1895 is stated at 91; and the State Railroad Commission is reported as stating the number killed during 1894 alone at 45. It is believed that many of these accidents and fatalities are directly traceable to imperfect vision in motormen. That the managers of trolley roads are sensible of this fact is evidenced by the action several months ago of President Beckley, of the Rochester Electric Street Railway, which is conceded to be one of the best managed and most efficient of this class of railroads in the United States, in ordering an examination of its motormen and conductors as to sight and hearing by Dr. Wheelock Rider, an eminent oculist and aurist of Rochester, and making provision for such examination of all applicants for places before employing them in the future. It is suggested that, aside from other legislation touching the operation of railroads, this one point of faculties, of seeing and hearing in the operating forces, as the positions where seeing and hearing are essential, ought to be covered by requirement of statute for examination by a competent oculist and aurist before applicants are taken into the railroad service. Information has been received that men dismissed from service of the Rochester road on account of defective vision and hearing found employment on the Brooklyn roads without question."

LABOR ARBITRATION IN FRANCE.

The following report on legislation on this subject in France was made by Mr. Charles W. Wilcox, Jr., our Consul at St. Étienne, and is dated December 6, 1894. In his report he says:

"Toward the close of the year 1892 the French Chambers enacted a law providing for 'conciliation and arbitration in conflicts between employers and workmen.' The act contemplates the voluntary submission by the parties interested of the questions at issue between them, bearing on the condition of labor, first to a committee of conciliation, consisting of delegates chosen by the respective parties; and, secondly, in case of failure to agree on the part of such committee, to a council of arbitration. The proceedings may be initiated by either party, or, in case of a strike, upon the invitation of the justice of the peace of the district or canton; but in all cases, the agreement of both parties to submit the question is essential. The process is substantially as follows:

"The parties—employers or workmen—file with the justice of the peace of the canton a written declaration setting forth the names, professions and domicile of the petitioners and of the persons to whom the proposal for conciliation or arbitration is to be addressed; the subject-matter of the conflict, with a detailed statement of the motives or reasons alleged by the respective parties; and the names, professions and domicile of the delegates chosen by the petitioners to assist or represent them. The number of delegates cannot exceed five, and they must be citizens of France. The justice of the peace thereupon delivers a receipt for the declaration, indicating the date and hour of the filing, and causes notice to be served on the adverse parties. An answer to this notification must be filed within three days, a failure so to do being taken as a refusal to submit the matter in controversy. Provision, however, is made for an extension of time upon application made within three days.

"If the proposition is accepted by the adverse parties, they must state in their answer the names, professions, and domicile of the delegates; these delegates being subject, of course, to the same provisions in relation to the number and citizenship as those chosen by the petitioners. After the acceptance is filed, the justice invites the parties or delegates to form at once a 'committee of conciliation.' The meetings of the committee are presided over by the justice. If an agreement is reached by the committee, it is reduced to writing by the justice and signed by the parties or delegates. In the event of a disagreement in committee, arbitrators are chosen on both sides, or, when practicable, a common arbitrator. If the arbitrators fail to agree, they can choose a new arbitrator or referee who will have the casting vote; if they cannot agree upon the selection of such referee, they declare the fact in writing, and, thereupon, such declaration, being transmitted by the justice to the president of the civil court (*president du tribunal civil*), the latter will appoint such referee.

"The decision of the dispute, drawn up and signed by the arbitrators, is remitted to the justice of the peace. The declarations and decisions are preserved in the office of the justice, who delivers a copy to each of the parties, and addresses another, through the prefect of the department, to the Minister of Commerce and Industry.

"In case of a strike, if the initiative has not been taken by any of the parties interested, the justice of the peace, by virtue of his office, calls upon the employers and workmen, or their representatives, to make known to him, within three days, the subject-matter of the controversy, with a detailed statement of the motives or reasons alleged, their acceptance or refusal of conciliation or arbitration, and the names, professions, and domicile of the delegates chosen, if any. If the invitation of the justice is accepted, the proceedings will follow the course heretofore indicated.

"The costs for the furnishing, heating, and lighting of the rooms necessary for the holding of the meetings of the com-

Photographed by Hart, Brooklyn, N. Y.

THE UNITED STATES ARMORED CRUISER "MAINE," BUILT AT THE BROOKLYN NAVY-YARD.

mittee of conciliation and councils of arbitration fall upon the commune, and the expenses of the committees and councils are taxed by decree of the prefect and are charged to the budget of the department.

"It will be noticed that under the law, the recourse to its provisions is purely voluntary, the intention and scope of the act being to furnish a method, not to prescribe a remedy. As to the enforcement of the decision of the council of arbitration the act is silent, and it is to be assumed that in case of a refusal to comply, the injured party would be remitted to his civil suit for damages.

"The recent publication of the report of the director of the Office du Travail, addressed to the Minister of Commerce and Industry, affords an opportunity for judging of the practical operation of the law. The report covers the year 1893. It appears that, during that year, there were 634 strikes, and that proceedings under the provisions of the act were initiated in 109 instances, in all but 7 of these instances a strike having been previously declared. In 56 cases the application came from the workmen; in 5 from the employers; in 2 from employers and workmen together, while the justice of the peace intervened in the remaining 46. The result of these 109 invocations of the law of arbitration is as follows:

"In 13 cases work was resumed before the law could be applied, and in 8 of these the justice had intervened, and in 5 the application had come from the workmen. In 45 other cases the resort to conciliation was frustrated by refusals to submit, 37 of these refusals coming from the employers, 6 from the workmen, and 2 from both sides. In the 37 instances of refusal by employers, the application had been made by the workmen in 28 cases, and the justice had intervened in 9. In the 6 instances of refusal by the workmen, the application had been made by the employers 3 times, the justice intervening in the other 3.

"In the 51 remaining cases, committees of conciliation were constituted, and in 30 instances a satisfactory solution of the differences was obtained, a conclusion being reached by the committee in 25 cases and by a subsequent arbitration in 5. In 9 of these proceedings the demands of the workmen were granted, in 3 refused, and a compromise decision reached in 18.

"The 21 other submissions failed of any practical result, 1 because two successive referees appointed by the President of the civil court declined to serve, 2 because the workmen refused to ratify the decisions, and the others by reason of a refusal, by one side or both, to consent to a council of arbitration or appointment of a referee.

"I am unable to obtain any official figures in relation to arbitration for the past year; but in his report to the Minister of Commerce and Industry, the director of the Office du Travail states that up to the time of writing—September 1, 1894—the recourse to the law had been larger, in proportion to the number of strikes, than during 1893.

"Charles W. Whiley, Jr., *Consul.*

"St. Étienne, December 6, 1894."

THE UNITED STATES ARMORED CRUISER "MAINE."

The act of Congress authorizing the construction of the armored cruiser *Maine* was passed on March 3, 1887, so that this vessel is among the first of the armored ships that were authorized to be constructed for the new navy. Together with the *Texas* she has been built at the Government yards—the *Maine* being built at Brooklyn and the *Texas* at the Norfolk yard. On page 124 we give a reproduction from a photograph of the vessel, taken shortly after she had been placed in commission.

The vessel is described in the reports of the department as a "steel-armored cruiser with two steel barbette turrets;" the length on the water-line is 318 ft., the breadth, 57 ft., with a mean draft of 22 ft. 6 in., and a displacement of 6,648 tons. The engines are of the vertical twin-screw triple-expansion type, and are capable of developing 9,000 H.P., and the calculated speed was placed at 17 knots.

As already intimated, the vessel is constructed of steel throughout except in those portions where some other material was especially specified, and great pains were taken that everything used about the hull and the fittings was of the best possible description, and that all wood used was thoroughly seasoned. The keel, which was laid in 1888, is formed, in its vertical portion, of plates weighing 20 lbs. to the square foot, and extends continuously throughout the length of the vessel; in the central portions—that is to say, between frames 12 and 74—it is $36\frac{5}{16}$ in. high. The flat keel is made of two thicknesses of plate, the outer weighing 25 lbs. and the inner 20 lbs. per square foot. The stem is of cast steel, made in two pieces, and is well supported for ramming by attachment to the protective deck and special strengthenings. The bow is strengthened by a horizontal ram plate 3 in. thick. The stern post is also of a steel casting, and, like the stem, it is made in two pieces. The upper piece is 3 in. thick, the lower end being secured to the protective deck armor, while the upper end is connected to the plating of the main deck. Cast steel is also used for the rudder and the struts carrying the shafts.

The vessel is divided into 15 water-tight compartments formed by 12 transverse bulkheads and one longitudinal bulkhead separating the engine-rooms. The transverse bulkheads are connected to the inner bottom and to the outside plating as well as to the longitudinal bulkheads by a single angle bar 3 in. × 3 in., weighing 7 lbs. to the foot. All of these bulkheads were carefully caulked and made water-tight. The same treatment was given to the magazines, light-boxes and trunks to the same, which were considered as water-tight compartments. For a length of 180 ft. amidships there is a belt of vertical steel armor extending from 3 ft. above the load water-line to 4 ft. below it, with a thickness of 12 in. from 1 ft. below the water-line to the top of the armor. From 1 ft. below the water-line to the armor shelf the thickness is tapered down to 6 in. in thickness. The top of the armor is rabbetted to receive the top plates of the berth deck armor. This armor is held in place by bolts that range from $4\frac{3}{4}$ in. to 4 in. in diameter. It is backed by 8 in. of wood that is secured to the skin plating by bolts $1\frac{1}{2}$ in. in diameter. The conning tower is built of steel 10 in. in thickness, and is elliptical in shape. It is connected with the armor deck by an armored tube $4\frac{1}{2}$ in. thick.

The ship is fitted with two revolving turrets placed *en echelon.* They are each equipped with two 10-in. guns which are placed at sufficient height to fire over the main deck. The guns of each turret can be fired simultaneously on a line parallel with the centre line of the ship, and they have an unobstructive fire on one side of 180° and on the other of 55° for the forward turret and 49° for the after turret. Each turret is protected by 7 in. of steel armor, the gun plates being of the same thickness. It was the original intention to use 10 in. in thickness for the armor of the turrets. All of the revolving parts of the turret are protected by a fixed barbette which has a steel armor 12 in. thick.

As in all of the other vessels that have been designed for the Navy, pains have been taken that the quarters for the officers and crew should be made as comfortable as possible, especial attention being paid to the methods of ventilation. The fore-and-aft bulkheads of the ward-room are made of sycamore veneered on white pine and given a dead finish. Seasoned white pine was used, however, for the athwartship bulkheads of these rooms. The state-rooms for the admiral and the captain are fitted in the same way.

The following is the list of boats that are carried: There is one 33-ft. steam cutter, one 28-ft. steam cutter, one 32-ft. sailing launch, one 30-ft. cutter, one 30-ft. barge, one 28-ft. cutter, two 29-ft. whale boats, one 28-ft. gig whale boat, one 20-ft. dingy, and two 63-ft. torpedo-boats, with all of the necessary fittings, the engines for which were illustrated in our issue of October, 1894; and the vessel itself will form the subject of a future illustration in this paper.

Communication between all of the important points of the vessel is provided for by the usual means of speaking-tubes, telephones and electric signals.

The engines are of the triple-expansion type and do not differ in their general design from the other engines that are used in the vessels of the navy, some of which are already familiar to the readers of this journal. The only features of any account that mark these engines are that while they are designed as triple-expansion engines they can be so disconnected as to be run as a compound, thus effecting a saving of coal and permitting a lower steam pressure to be carried at the same time. Then the valves are operated through a rocker arm instead of being directly connected, as is usually the case. The engines are built as rights and lefts, and are placed in separate water-tight compartments that are separated by a fore-and-aft bulkhead. They are of the vertical inverted cylinder direct-acting triple-expansion type, each having a high-pressure cylinder $35\frac{1}{2}$ in. in diameter, an intermediate cylinder of 57 in. diameter and a low-pressure cylinder of 88 in. diameter; the stroke of all of the pistons being 36 in. The collective I.H.P. of the propelling engines, air-pump and circulating-pump engines is 9,000 when the main engines are making about 132 revolutions per minute. All of the cylinders of the main engine are steam jacketed, and they are arranged with the high-pressure cylinder of each aft and the low-pressure forward, and it is the latter that is disconnected when working at a low power. The main valves are of the piston type, worked by Stephenson links

of the double-bar type. In the construction of the engines, the piston valves, valve liners and valve gear were made interchangeable. There is one piston valve for each high-pressure cylinder, two for each intermediate cylinder, and three for each low-pressure cylinder. The framing of these engines consists of hollow cast-steel columns trussed with wrought-iron stays. The engine bed-plates are also of cast steel, and are supported directly upon the keelson plates that are built into the vessel. The crank shafts are made in interchangeable sections, and all of the shafting is hollow.

The condensers are made entirely of composition and sheet brass, and each one contains a cooling surface of 7,010 sq. ft., measured on the outside of the tubes, the water passing through the tubes. Each propelling engine is provided with a double, horizontal, double-acting air-pump worked by a vertical compound engine. The circulating pumps are of the centrifugal type, and are worked independently for each condenser. The propellers are three-bladed, and are made of manganese bronze.

The boiler capacity is made up of eight single-ended steel boilers of the horizontal return fire-tube type, 14 ft. 8 in. outside diameter and 10 ft. long, constructed for a working pressure of 135 lbs. per square inch. They are placed in two equal groups, with fore-and-aft fire-rooms. Each has three corrugated furnace flues made by the Continental Iron Works, of Brooklyn, N. Y. These flues are 3 ft. 6 in. in diameter. The total heating surface of all of the boilers is about 18,800 sq. ft., measured on the outside of the tubes; and the grate area is about 553 sq. ft., giving a ratio of about 1 to 34. Each boiler compartment is provided with a vertical duplex main feed pump and a duplex auxiliary feed pump, each of these pumps being complete in itself.

The forced draft in each compartment consists of two blowers, which discharge into a main air duct under the fire-room floors, from which a branch duct leads to the ash-pit of each furnace. Means are also provided for closing the ash-pits when under forced draft for preventing the leakage of gases out of the furnace doors. The draft of each furnace is further regulated by an independent damper for each one.

The ship is provided with the usual equipment of steam reversing gears, ash-hoists, turning engines, auxiliary pumps, engine-room ventilating fans, a combined windlass and capstan, steam winches, a steering engine, engine and dynamo for working various small machinery and for lighting the engine and fire-rooms, a hydraulic pumping plant for various purposes, turret-turning engines, a distilling apparatus, as well as other minor pieces of supplementary machinery, tools, etc.

As we have already said, the crank shafts of the two engines are interchangeable. They are 7 ft. 9 in. long over all and are fitted with a bearing on each side of each crank that is 13 in. in diameter. This shaft is increased to a diameter of 13½ in. at the eccentric seatings. The crank-pins are 14 in. in diameter and 14 in. long, and the webs are 17½ in. wide and 9 in. thick. A 4-in. hole is bored through each shaft and crank-pin, which are set at angles of 120° with each other, the high-pressure crank leading, followed by the intermediate and the low pressure in the order named.

There are two gears for revolving each turret, each consisting of a three-cylinder hydraulic engine, driving a pinion and spur on a horizontal shaft which carries a bevel wheel meshing into a rack on the under side of and revolving the turret. The engines have been so designed that each has the power to turn the turret at the rate of one revolution per minute with the guns run out and the vessel on an even keel, while the two together have the power to revolve the turret at the same speed with the vessel heeled 10°. In general method of operation these engines are similar to those that were illustrated in the April, 1894, issue of The American Engineer and Railroad Journal—that is, they are started, stopped and reversed by a valve which changes the pressure and exhaust ports. There is also a hydraulic locking device for each turret consisting of a cylinder, plunger and locking bolt with the necessary valve gear.

The armament of the *Maine* consists of four 10 in. breech-loading rifles, six 6-in. breech-loading rifles. The secondary battery consists of eight 6-pdr. rapid-fire guns, eight 1 pdr. rapid-fire guns and four Gatlings.

The vessel is now in commission; but the two large torpedo boats that are intended to be carried upon her decks are not yet on board. One is ready for delivery, however, and the other will be finished in a few days.

The engines were built by the Quintard Iron Works, of New York, and are considered by the officers of the Engineering Department as being remarkably fine specimens of engine designing and construction. The contract called for the construction of engines that should develop 9,000 H.P., and this was exceeded in the trials by 171.45 H.P., as shown by the abstract of the official report that is given below;

DATA OF OFFICIAL TRIAL, U. S. "MAINE."

Draft of water at beginning, forward	18 ft. 2 in.	
" " " " " aft	19 ft. 1 in.	
" " " " end, forward	17 ft. 10 in.	
" " " " " aft	18 ft. 11 in.	
" mean, for trial, forward	18 ft.	
" " " " aft	19 ft.	
Displacement at mean draft on trial	5,500 tons.	
Area of midship section at 18 ft. 6 in. mean draft	906 sq. ft.	
Wetted surface	21,850 sq. ft.	
I. H. P. (total) per 100 sq. ft. of wetted surface	42 53	
" per 100 sq. ft. of wetted surface at 10 knots in ratio of 3.5 power	6.0142	
Mean speed	17.45 knots.	
Slip of screws, mean, starboard	12.805 per cent.	
" " " " port	10.205 per cent.	
Speed³ × area immersed midship section ÷ I.H.P	518.26	
" ³ × displacement ⅔ ÷ I H.P	165.21	
Temperatures in degrees Fahr., injection		63.0
" " " " discharge	114.	99.5
" " " " hot well	127.2	127.3
" " " " feed	127.3	127.3
" " " " engine rooms, upper	146.	
" " " " " " lower	99.	
" " " " fire rooms, forward	127.	
" " " " " " aft	134.	
Revolutions of blower per minute, main boilers	450.	
Air pressure in in. of water, ash pits	1.074	
" " " " " " furnaces	.92	
H.P. cylinder, mean pressure	54.372	53.656
I.H.P	1,216.89	1,165.56
I P. cylinder, mean pressure	20.907	19.597
I.H.P	1,218.35	1,108.94
L P. cylinder, mean pressure	16.236	16.267
I.H.P	2,261.75	2,200.00
Aggregate equivalent mean pressure on L.P. piston	33.7175	33.0855
I.H.P. collective of each main engine	4,696.95	4,474.50
" " " both " engines	9,171.45	
" of combined air and circulating pumps	28.25	24.593
" collective of " " " " (2)	52.843	
" of all forced draft blowers (4)	38.068	
" " main feed pumps (2)	15.429	
" " other auxiliaries	14.856	
" " all auxiliaries	121.1962	
" each main engine, air and circulating pump	4,725.20	4,499.093
" both main engines, air and circulating pumps	9,224 293	
" total of all machinery in use	9,292.646	
Indicated thrust (I.H.P. main engines)	57,354.40	
" " per sq. in. of surface of thrust bearings	59.31	
Cu. ft. swept per minute by L.P. piston, per I.H.P. of main engines	6.73	6.87
Sq. ft of H. S per I.H.P	2 0462	
" " cooling surface per I H.P	1.5087	
I.H.P. of all machinery in operation, per sq. ft. of G.S	16.1938	
I.H.P. per ton of propelling machinery, boilers and water	14 18	

Coal Consumption.

Sq. ft. of G.S. in use	573.84
" " H.S. in use	19,015.36
Kind and quality of coal used	Pocahontas, good quality.
Coal burned per hour, actual weight	20,272 lbs.
" " " " per sq. ft. of G.S	35.327 lbs.
" " " " " " " H.S	1,066 lbs.
" " " " " I.H.P. of all machinery	2.1815 lbs.
" " " " " " " main engines, air and circulating pumps, and feed pumps	2.194 lbs.

An examination of the above table will show that the contract speed was exceeded by 0.45 knot. The only thing about the vessel that has excited adverse criticism is the high temperature of the engine and boiler rooms. A temperature of 146°, like that which prevailed in the upper engine room, is certainly too high for long-continued or violent exertions, while 134° is more than firemen can endure and work the boilers to advantage. It seems that the hatch from which the hot air from the engine-room has to escape measures 4 ft. × 8 ft., and that something more than one-half of the area of this hatch is blocked by an armored grating. This is, however, a matter that can probably be remedied by the use of exhaust fans or other methods of artificial ventilation. In other respects the vessel has more than come up to the expectations of the designers as laid down in the specifications.

THE GAS-MOTOR STREET CAR IN SERVICE IN GERMANY.

Our consul in Frankfort, Mr. Frank H. Mason, under date of November 30, 1894, has made the following supplementary report on the gas-motor street cars used in that country. He says:

"In two previous reports of this series * some account was given of a new method of propulsion for street and suburban railway cars, by means of a gas engine, as first applied and put in operation at Dresden, and subsequently introduced

* See American Engineer and Railroad Journal for March, 1894, and October, 1894.

experimentally into Great Britain. The earliest models of this car were unduly heavy, complicated and expensive; but it has since been improved and simplified to a point of economy and efficiency which it is now thought may fairly challenge expert criticism. At the beginning of August last four cars of the latest and most improved type were put into regular service upon a suburban railway leading from Dresden along a busy boulevard to the village of Wilden Mann, a distance of nearly 3 miles. These cars have since been in daily service from six o'clock in the morning until ten at night, working side by side over part of the line with horse cars, with which the road was originally equipped, so that a close temporary comparison is offered between the two systems, operated under identical conditions.

"With the exception of some slight modifications, designed to minimize the oscillation of the vehicle at the moment of starting or when at rest with the engine in motion, these cars are of the same general type as the one described in the last previous report as being in experimental service at Croydon, in England.

"Outwardly the car's appearance is precisely similar to that of an ordinary double-decked horse car, having stairways from each platform to the seats on the roof. All the machinery is inclosed and concealed from sight; there is no smell of gas, no noticeable heat from the engine, and no undue noise or jar when the car is stopped or set in motion. The motor is a double-cylindered gas engine of the Otto model, placed under the seat at one side of the car, and reached for purposes of oiling, cleaning, or repairs by doors which form panels in the outer wall of the car, and when closed are not noticeable. The engine is of the latest type, in which the gas is ignited at each stroke by an electric spark from a small battery located in the engine space, so that the car is put into or out of service by turning a knob, which opens or closes the circuit.

"The engine is kept in motion while the car is in service, and the whole is managed by the driver, who, standing on the front platform, has within reach the brake wheel, on which is fixed the alarm bell and a movable lever which, when in an upright position, leaves the engine disconnected with the running gear of the car and cuts off the gas supply so that but one explosion takes place in one of the cylinders at each eighth revolution, the motion of the engine being meanwhile maintained and steadied by the fly-wheel, which is 4 ft. in diameter and of corresponding weight. When the lever is pushed to the left, it turns on a two thirds supply of gas in both cylinders and brings into engagement a friction clutch which connects the engine shaft with the wheel axis and gives the car a speed of 4½ miles per hour. Pushing this lever to the right turns on the full gas supply and brings into connection a friction clutch of larger diameter, which gives the car a speed of 9 miles per hour. A second lever is provided for reversing the engine and direction of movement.

"The gas supply is carried in three cylindrical reservoirs of boiler iron about 10 in. in diameter, two of which are hung transversely under the floor at each end of the car, while the third is placed beneath the seat at the side opposite the engine. The weight is thus to some degree equalized. The three reservoirs weigh together about 550 lbs., and contain 33.5 cub. ft. of gas, condensed to a pressure of eight atmospheres by means of an ordinary force pump at the end supply station. This pump is worked by a gas engine of 8 H.P. The whole apparatus costs, in Germany, $2,380.

"A fourth cylindrical reservoir, containing water for cooling the engine cylinders, is placed beneath the double seat along the middle of the deck roof, whence the cool water descends and the warm ascends automatically through concealed copper tubes, so effectively that the water, being continually cooled in the exposed reservoir, is used over and over again, and keeps the cylinders down to the requisite temperature. The gas reservoirs are filled at the end station by means of a flexible hose leading from the condenser, and the filling process occupies from 30 seconds to a minute, according to the calibre of the hose and the degree to which the gas in the reservoirs has been previously exhausted.

"The ordinary car is equipped with a gas engine of 9 H.P., and carries 36 passengers—viz., 14 seated inside and 12 on deck, with platform standing room for 10 more. The car costs, in Germany, 12,000 marks ($2,856). When it is desirable to make the motor car capable of drawing a trailer during hours or days of increased travel, the engine is increased to 12 H.P., and the car then costs, complete, $3,094. The work of the new motor cars, which have now been in service at Dresden during a period of three months, seems to have fulfilled substantially all that has been claimed in their favor. The car is perfectly manageable, stops from full speed within its own length, starts without noise or shock, is free from heat or smell, runs as smoothly as a horse car on what would be considered in America a rather rough and poorly constructed track, far surpasses a horse car in speed when the way is clear, and is handled safely and easily on a boulevard which at certain hours is crowded with traffic that renders frequent and sudden stops necessary. At the slower rate of speed it mounts a grade of 1 in 22, and traverses uphill a curve of 40 ft. radius.

"Exact and conclusive comparisons of net cost and operating expenses, as compared with other systems of propulsion, can, of course, be deduced only from prolonged and continuous service covering a period of years, but from the experience thus far gained, some of the essential factors of the problem may be closely approximated. Gas is furnished by the street gas company in Dresden at its usual rate, 3 cents per cubic metre, or about $1.05 per 1,000 cub. ft. At this price, the cost for gas consumed by a car in service is 1 cent per car kilometre (1⅗ cents per car mile). The initial cost of a gas motor car does not differ much from that of a new horse car with its complement of horses. The gas reservoir station for a large line occupies but small space, and can be managed by one or two men, and the cars, when not in service, consume nothing and only require a shed for shelter from the weather. One cleaning per week is found to be sufficient for the machinery, which is tightly inclosed and protected from dust and dampness.

"In Germany, good horses for tramway service cost from $200 to $250 each, and their average efficiency does not exceed three years, at the end of which time they are either worn out, or, if salable for breeding purposes or farm work, they bring only from one-fourth to one-half of their original cost. In Dresden the annual depreciation of street-railway horses from all causes—disease, accident and inevitable wear from hard service in all weathers on hard pavements—is reckoned at from 18 to 22 per cent. of their value, and this percentage is said to be still higher in tropical or very cold countries, where only inferior breeds of draft horses are available and the conditions of animal life are less favorable.

"The cost of keeping a gas motor car in repair, although not yet fully demonstrated for a long period, is estimated at not more than 5 per cent. annually of its original cost, and with ordinary care such a car should last as long as two or three outfits of horses, which latter are, moreover, subject to epidemics and to conscription, in case of sudden war, for military service. So far, therefore, as experience has yet demonstrated, the mechanical efficiency of the gas-motor car would seem to be assured; and a comparison of its cost of construction and operation with the known expense of working horse, cable, steam, and electrical tramways in the United States can hardly fail to invest the new motor, as a competitor in the same field, with a serious practical interest. Further improvements will, no doubt, still better adapt it to its work under varying local conditions, but in its present form it would not seem to be well suited to lines which have grades more abrupt than 1 in 20, and it has not yet been proven to be well adapted to countries which are subject to frequent and heavy falls of snow.

A NEW CAR FOR THE UNITED STATES.

"In the latter of the two previous reports on this subject, it was stated that a gas-motor car of the most improved type was then under construction in England, and would be sent to the United States for trial and exhibition in October. In order to adapt the invention more fully to the peculiar requirements of our country, a second and entirely new model has been invented, with the result that the contemplated exhibition in the United States has been unavoidably postponed until some time in February.

"The fact has been taken into account that in a country where sudden and frequent snow falls occur in winter, a motor of higher power is requisite, and that in order to meet more fully the wants of American tramway companies, the machine must be so modified as to be readily applied to cable, electrical, and horse cars already in use, thereby economizing all but the running gear of such vehicles. The following modifications have therefore been made in the Dresden model as above described: The motor has been condensed in compass so as to be readily set upon a four-wheeled truck, wholly independent of the upper portion of the car. The fly-wheel and driving machinery are laid in a horizontal position between the wheels, and two sets of springs are provided, those supporting the machinery resting directly on the axles, and those supporting the car body bearing on the truck frame, the two sets of springs being entirely independent of each other. By this clever device the vibration caused by the engine at the moment of starting is reduced to a minimum, and the whole apparatus so simplified that when the body of any ordinary street car is bolted to the springs and the cool-

FIG. 13.

FIG. 14.

VIEWS ON THE WESTERN SIBERIAN RAILWAY.

water reservoir and its connecting pipes are attached, the car is ready for service. The motor has been increased from 8 H.P. to 20 H.P., and its maximum speed, with the larger friction clutch in engagement, to 12 miles an hour.

"Thus, within less than a single year after having first been put in operation, the Lührig gas-motor car has been so modified and improved as to constitute a practically new machine, in which all the mechanical and economic difficulties which were at first encountered seem to have been successfully overcome. "FRANK H. MASON, *Consul-General.*

"FRANKFORT, November 30, 1894."

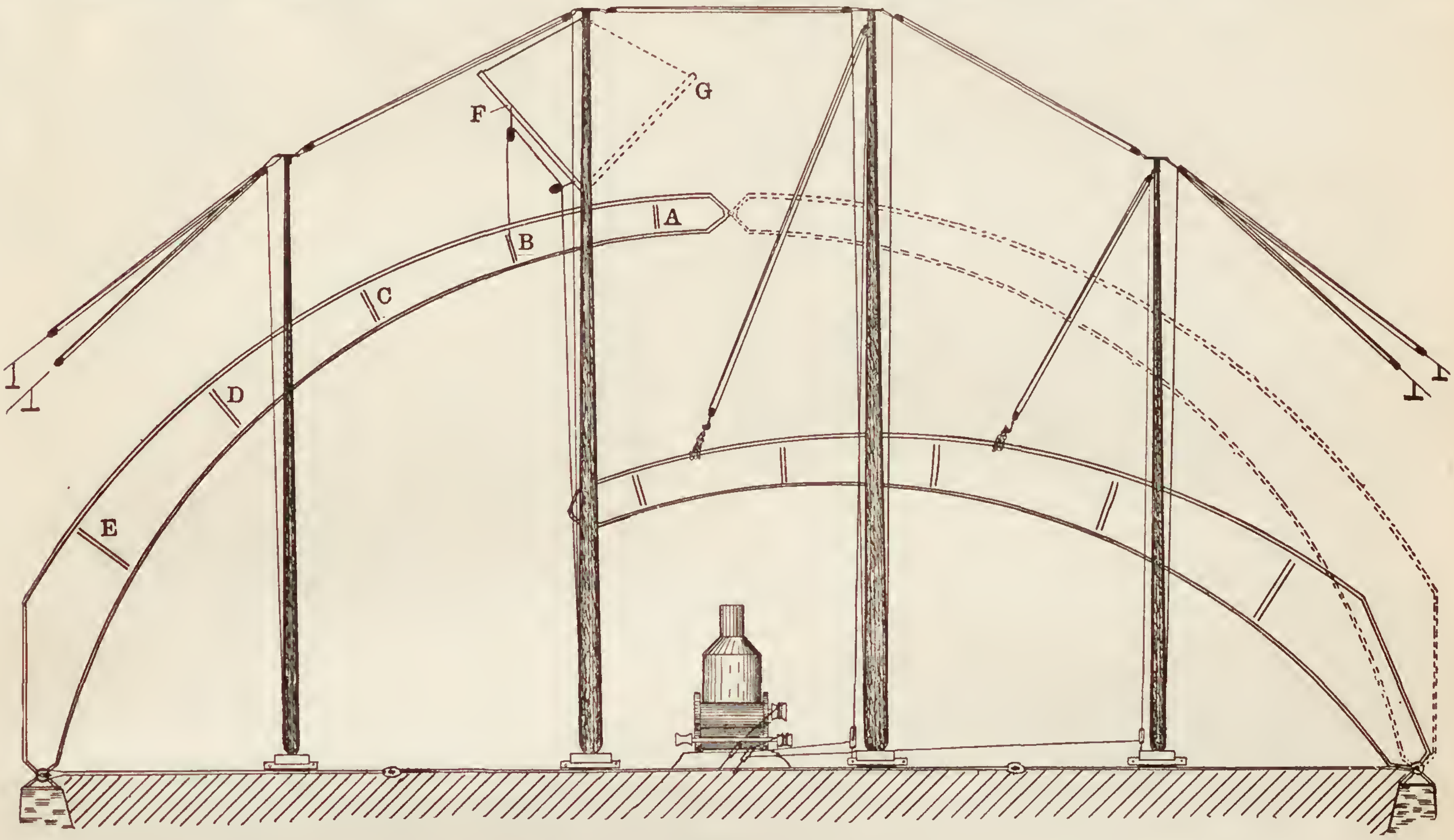


Fig. 1.

MAST TRAVELLER FOR ERECTING ROOF TRUSS.

VIEWS ON THE WESTERN SIBERIAN RAILWAY.

THE two views, figs. 13 and 14, herewith complete our series of illustrations on the line of this great work. Fig. 13 represents a general view of an incomplete station at Kourhan, and gives a very good idea of the character of the country and of its resemblance to our Western prairies. The view of the incomplete foundations also shows that the Russians are doing some very substantial work.

Fig. 14 is a number of sledges loaded with barrels of tallow and drawn by camels at a station in Kourhan. Most people in this country have an idea that a camel is an animal adapted to warm climates only. Our view and the testimony of travellers in Russia show that they are adapted for service in countries where snow falls and sledges are used.

MAST TRAVELLER FOR ERECTING HEAVY WORK.

By JAMES F. HOBART.

FRAME travellers for erecting heavy trusses and iron buildings in general are expensive tools to handle and to build In order to be satisfactory, a frame traveller must be stiff, well built, contain a large number of devices for handling, raising and conveying material, and it must be mounted upon car wheels and railroad iron or some other stiff form of metal.

To construct, operate, remove and transport the traveller and its accompanying material will cost a large percentage of the amount allotted to erection of the iron-work.

In the erection of the large trusses which form the roof of the drill shed of the new Fourteenth Regiment Armory at Eighth Avenue and Fifteenth Street, Boooklyn, no frame traveller was used, the entire job being done in a most expeditious manner by the use of a four-mast traveller, as shown by fig. 1. The truss roof is composed of 12 steel arches, covering an area of 195 ft. 4 in. wide, by 260 ft. $\frac{3}{4}$ in. long. Each truss has a span of 195 ft. 4 in., and weighs about 70,000 lbs.

The outside radius of the roof arch is 114 ft. $2\frac{13}{32}$ in. The inside radius, 95 ft. $3\frac{25}{32}$ in.; the vertical height of truss is 80 ft., leaving 75 ft. clear from floor to roof. Twenty-five ft. vertical height is left on outside of the arch, and radii drawn from these points subtend an angle of 152° 55′ 10″, the truss forming a true circle for that distance on angle. The inner sweep forms a true circle through 117° 32′ 32″.

The trusses were constructed by the Elmira Bridge Co., and erected by Milliken Brothers, who hold the contracts for the structure. Expansion is amply provided for, each half truss being hung upon a steel pin $4\frac{5}{16}$ in. in diameter, except one truss at each end of the shed, which has 5-in. pins and is tied together by rods 2 in. square, two being used to each truss. The inside trusses are supplied with $1\frac{1}{2}$-in. rods. Each arch truss is built in two pieces, and is hinged together at the top by a $4\frac{5}{16}$-in. pin. This form of construction allows of perfect expansion adjustment. Each pair of arches is connected together by four steel struts, making 13 bays; the ends of struts in end bays being built solidly 12 in. into the brick end walls of the building.

Three expansion bays, one the second from each end, the third in the middle, take care of the variations of heat and cold. The struts are put up with $\frac{15}{16}$-in. rivets; but the expansion bays have holes slotted to $\frac{15}{16} \times 1\frac{1}{4}$ in., and $\frac{7}{8}$-in. bolts are used in the erection.

The steel arches are built up in sections of a size to be easily handled by teams, and are completed in the building, each half truss (see fig. 1) being put together complete and riveted throughout while lying on the ground. Each part of the truss can thus be put in place while it is lying on the ground, and every rivet driven except those which hold the bay struts in place.

For erecting the trusses the four-mast traveller shown in fig. 1 is used. The two outside masts are each 85 ft. high, the two central masts 104 ft. They are stayed and guyed as shown, being connected to each other by tackle controlled by ropes leading to the base of each mast.

Two end guys lead from the top of each end mast, and are made fast to ground anchors buried about 30 ft. apart and located in the strut 90 or 100 ft. from the base of the outside masts. These guys are each attached to a threefold tackle

at the top of each mast, the rope from each tackle leading to and being made fast at the base of each mast; two side guys to each mast were also attached and made fast. These guys may be seen in fig. 2.

The engraving (fig. 1) shows very plainly the arrangement of the masts and guys. It also shows one-half of a truss in position, the other half being in the act of being raised, power being supplied for all hoisting by the three-drum hoisting engine shown in the middle of the engraving. The row of masts are so set and located that the trusses shall bear against and slide up their sides during the raising process; this furnishes a guide for the trusses while they are going up. This, with the proper use of temporary guy ropes attached to the trusses, serves to keep things where they belong during the raising process.

Fig. 2 shows the location of mast and truss during raising, also while putting in the bay struts. The masts are so located (see fig. 1) that they come about half-way between the struts *a* and *b*, *c* and *d*. This arrangement makes it possible to erect two bay struts from each mast by means of a little independent boom, *f*, which may be quickly put upon any part of the mast. The boom is shown in position for putting in strut *b*; to put in strut *a* the boom is simply pulled around to the position shown by the dotted lines at *g*.

After the two half trusses have been put in place upon the three pins the masts are firmly lashed to the iron-work of the truss and the boom sent aloft and made fast, as shown in fig. 2. "Throat" and "peak" halliards are used; the boom being sent up yoke end first by the throat halliard, which is carried to the hoister. A "down-haul" is seen in fig. 2, which keeps the boom from going too high. As soon as the throat of the boom is in place the peak is hauled up and the boom put in position by the pair of guy ropes shown.

A snatch-block is made fast to the mast between the top of the roof truss and boom; through this block the hoisting rope from the boom tackle is put. Its function is to bring the line of pull in line with the mast, so the boom can be easily handled by its guy ropes, while the struts are being sent aloft and put in place.

Fig. 3 shows the boom and its rigging bent as for handling the struts. It will be noted that there is no fixed rigging about this boom. No eye-bolts, sheaves, or mortises. When a block is wanted in a certain place on this boom (or on the mast either) it is "seized on" with a few feet of inch rope, and, *presto*, the boom is ready for use, whereas if it had been a concern with fixed rigging it may not have answered half as well for the particular work in hand. Indeed, it may have been necessary to make a special boom, which probably would have been useless for the next job to be done.

A peculiarity in the two taller masts lies in the manner in which they have been spliced. Masts 104 ft. high don't lie around very plenty; and if a stick 120 ft. long was wanted it would make necessary the splicing of more timber—a slow and costly job. But, by taking off the short pieces and putting on those of the required length, the 120-ft. masts can be quickly made up.

It will be seen in fig. 4 that the splices, while much alike, are not the same on both masts. Indeed, one is male, the other female; and it is possible to put the main part of both masts together to make a stick over 180 ft. long. When thus

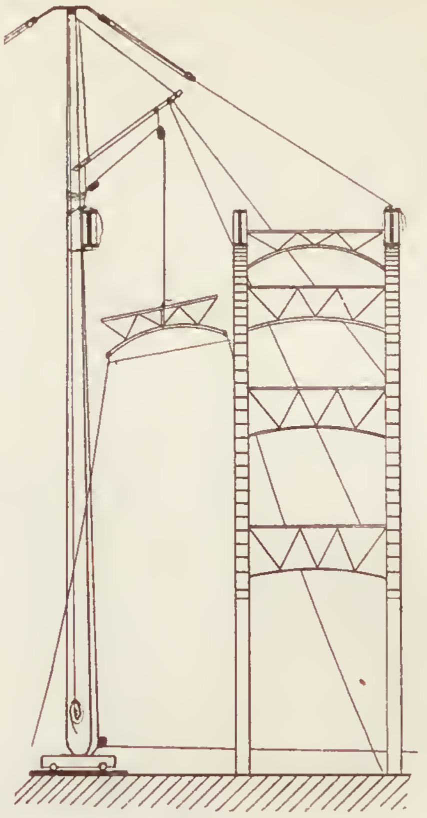


Fig. 2.

PUTTING IN BAY STRUTS.

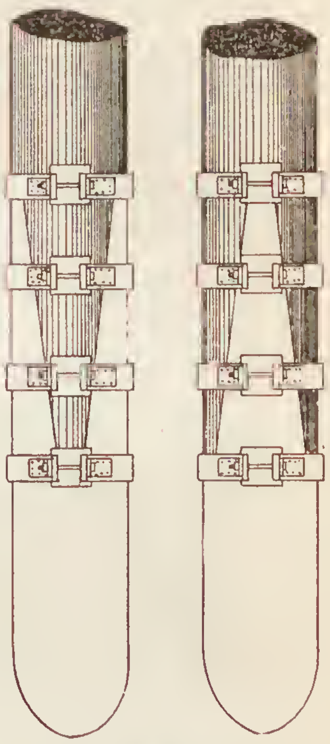


Fig. 4.

DUPLEX MAST SPLICE.

spliced, the long stick would be the biggest in the middle and taper toward each end, but that would be no disadvantage; and, for erecting a tower or an iron chimney, would possess infinite possibilities in the way of doing work well, cheaply and quickly.

THE JOY VALVE GEAR.

For some reason this form of valve gear has never met with the favor in this country which its merits seem to deserve. In Europe it has been extensively introduced, and has been in continuous use for many years on locomotive and marine engines. Possibly one reason why American locomotive engineers have not taken it up is because no simple explanation of its working and describing how it should be laid out was obtainable on this side of the Atlantic. To meet this want Mr. Joy has published a little pamphlet with the title "Rules for Laying down the Centre Lines of the Joy Valve Gear," which is now issued in a third edition. Probably most of our readers, like ourselves, have never seen a copy of these "Rules" before. Quite recently, through the thoughtfulness of Mr. Clement E. Stretton, who devotes the major part of his life in doing favors to other people, we have received a copy of this excellent little manual, which we take pleasure in reprinting

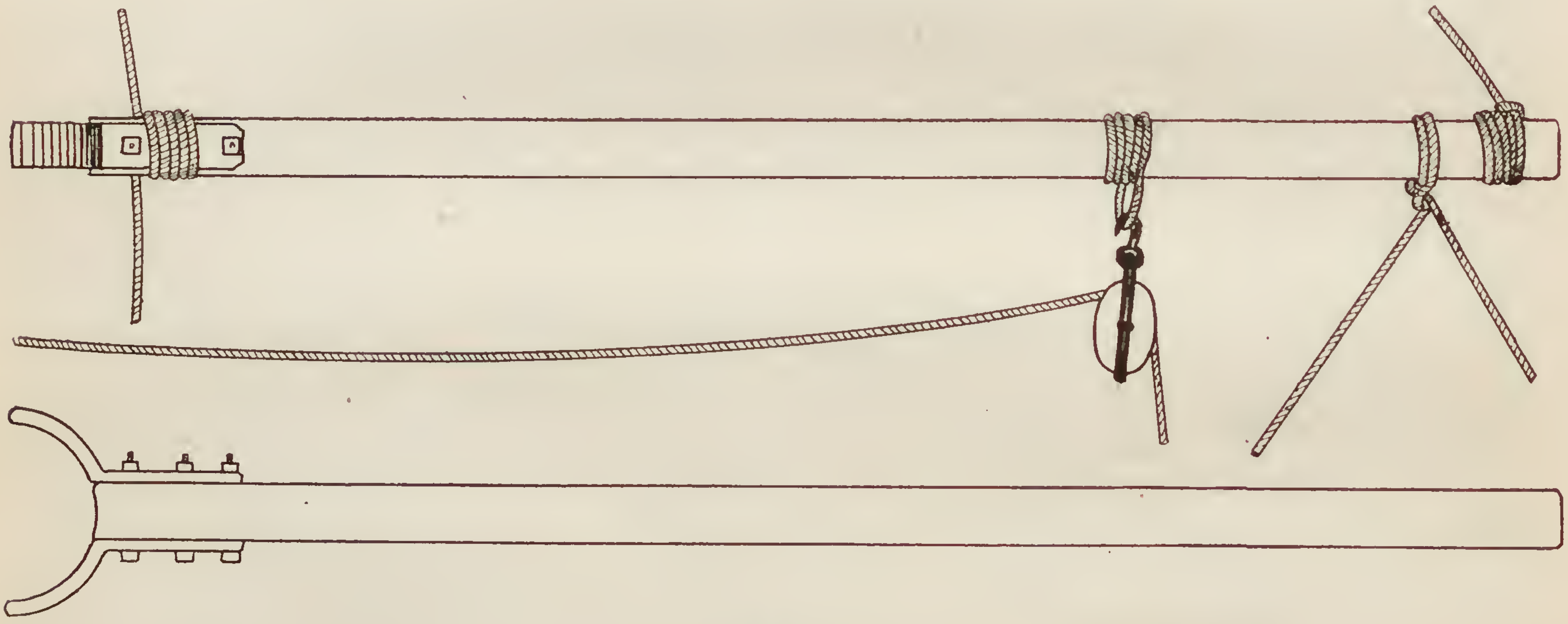


Fig. 3.

ADJUSTABLE BOOM.

with some amplifications. Before doing this a little explanation of the general construction of the Joy gear may not be out of place. A form much used in England on locomotives is represented by fig. 1, from which it will be seen that it consists of a "*connecting link*," 1, which is pivoted to the connect-

double the stroke of the valve, to avoid too great an angle of the slide link when angled for full forward or backward gear.

Having chosen the point d, draw a vertical line, $z\ z'$, through it and at right angles to $a\ a$, and mark off the two points $e\ e'$ on each side, these being the extreme positions of the point

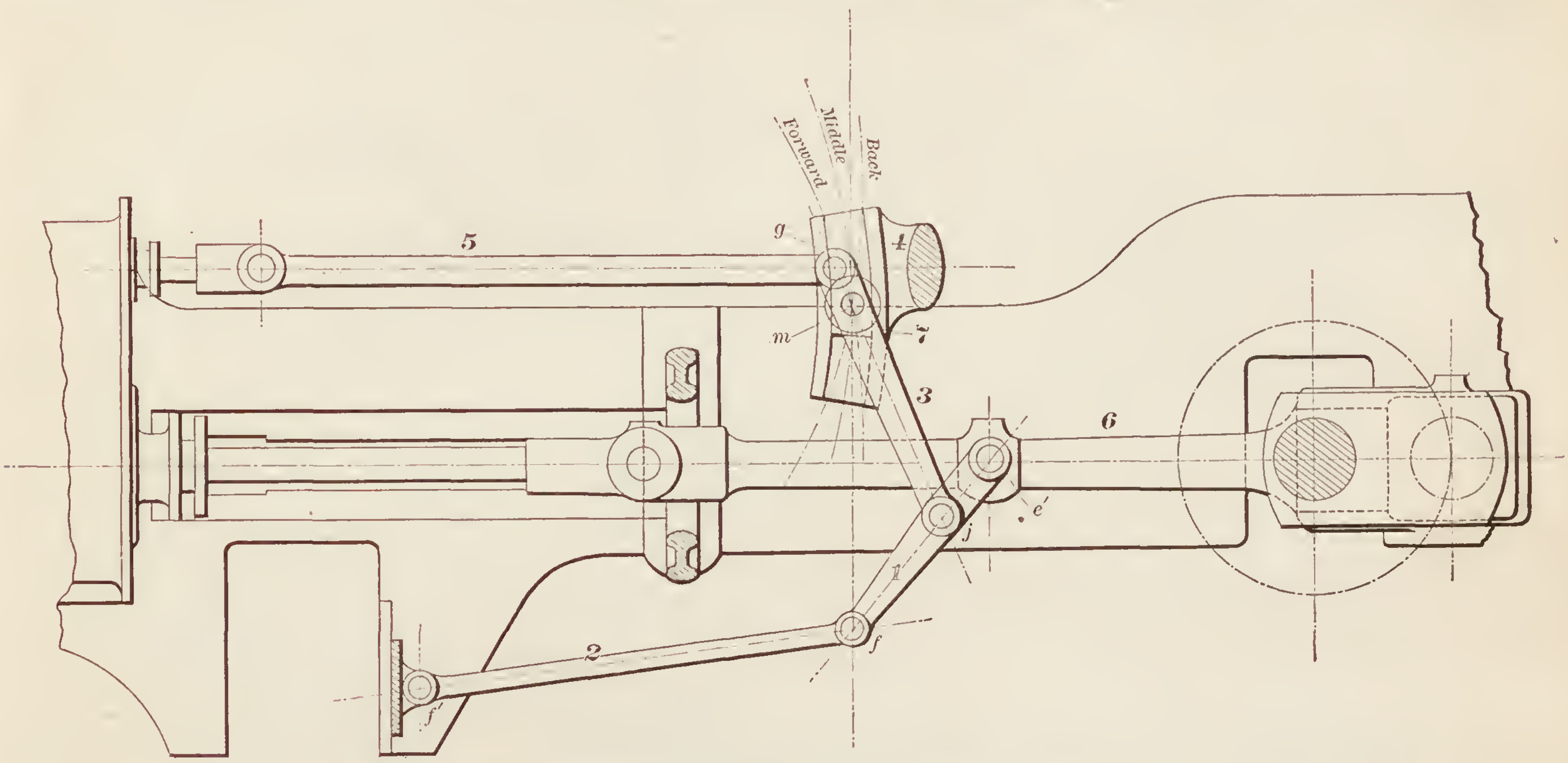


Fig. 1.

JOY VALVE GEAR AS APPLIED TO AN ORDINARY LOCOMOTIVE.

ing-rod 6 at e'. The lower end of the link 1 is connected to an "*anchor link*," 2, at f. This anchor link is attached to a fixed pin or fulcrum at f'. The main valve lever 3 is connected to the connecting-link 1 at j, and is fulcrumed at m to a block, 7, which slides vertically in a curved link, 4. The upper end g of this lever is connected to the valve-rod 5. The link 4 is attached to a shaft, represented by a dotted circle whose centre is at m. This shaft can be turned so as to bring the link into different positions of inclination, as shown by the dotted centre lines marked "forward," "middle" and "back." It is evident that as the crank revolves that the lower end of the valve lever 3 will be moved horizontally and also vertically, and will carry the block 7 with it in its vertical movement. The upper end $g\ m$ of the lever is proportioned so that the horizontal movement of j will move the valve an amount equal to its lap and lead, so that when the crank is at either of its dead points the block 7 will be in the middle of the link, and the valve will then be moved so as to give the required lead opening at either end of the cylinders. It is obvious, too, that if the link is inclined the vertical movement of the block will also cause the fulcrum m to be moved horizontally, and that this horizontal movement will be imparted to the valve-rod and the valve. The amount of this horizontal movement will be in proportion to the inclination of the link, so that the travel of the valve can be regulated by giving the link different degrees of inclination, or it can be reversed by changing the inclination, as indicated by the dotted lines.

Fig. 2 represents this gear applied to a vertical overhead marine engine, the operation of which will be readily understood from the preceding description.

Now, for laying down the centre lines of this gear, Mr. Joy has given the following

RULES.

Lay down the centre line of the cylinder $a\ a$ (fig. 3) and that of the valve spindle $b\ b$ at the relative distances required for the engine to which the application is to be made, the valve spindle centre line being, however, in the plane of the vibration of the connecting-rod. Draw the path of the crank-pin $h'\ c'\ a\ c''$ and the centre lines of the connecting-rod $c\ c'$, $c\ c''$ for both upper and lower positions when the piston is at half-stroke. Take a point, d, on the centre line of the connecting-rod, where its vibration between d' and d'' is equal to about double the length of the full stroke of the valve (it is better to allow rather more than less). It may, however, be chosen very much to suit the other arrangements of the engine, such as the position of the slide-bar brackets, etc., getting, however, if possible, a vibration of the connecting-rod fully equal to

d on the connecting-rod for front and back stroke; from these points draw lines to a point, f, on the vertical, so far down that the angle between them shall not be more than 90°; less is better, if there is room to allow of it (these will represent the centre lines of the "*connecting link*" marked 1, pinned to

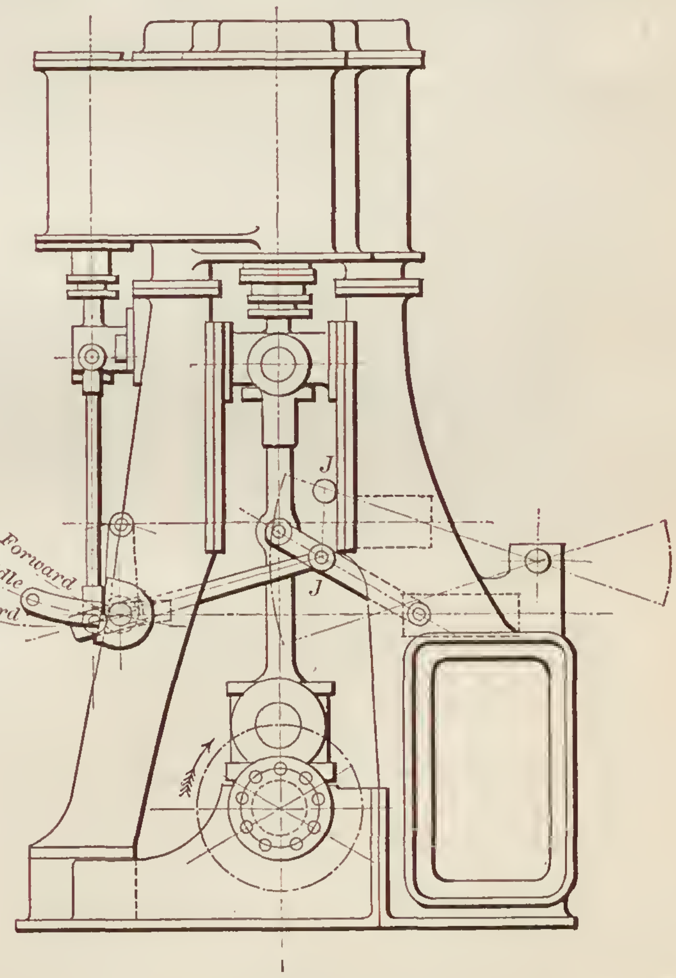


Fig. 2.

JOY VALVE GEAR APPLIED TO OVERHEAD MARINE ENGINE.

the connecting-rod in figs. 1, 3 and 4). The point f, which will rise and fall with the vibration of the connecting-rod, is to be controlled as nearly as may be on the vertical line by a link pinned either forward near the cylinder at f', or, if more convenient, it can be pinned backward near the crank. This link,

which is called the "*anchor link*," is marked 2 in the same figures, or the point f may run in a slide, see f''', fig. 4.

Next, on the valve spindle centre line $b\ b$, mark off on each side of the vertical $z\ z$ the amount $g\ g'$ and $g\ g''$ required for lap and lead, the one $g\ g'$ being "lap" and "lead" for the front end of the cylinder, and $g\ g''$ being "lap" and "lead" for the back end of the cylinder. Then, assuming the piston to be at the front of the cylinder, and the centres of the connecting-rod to be at $h\ h'$ (h' being the crank-pin), the point

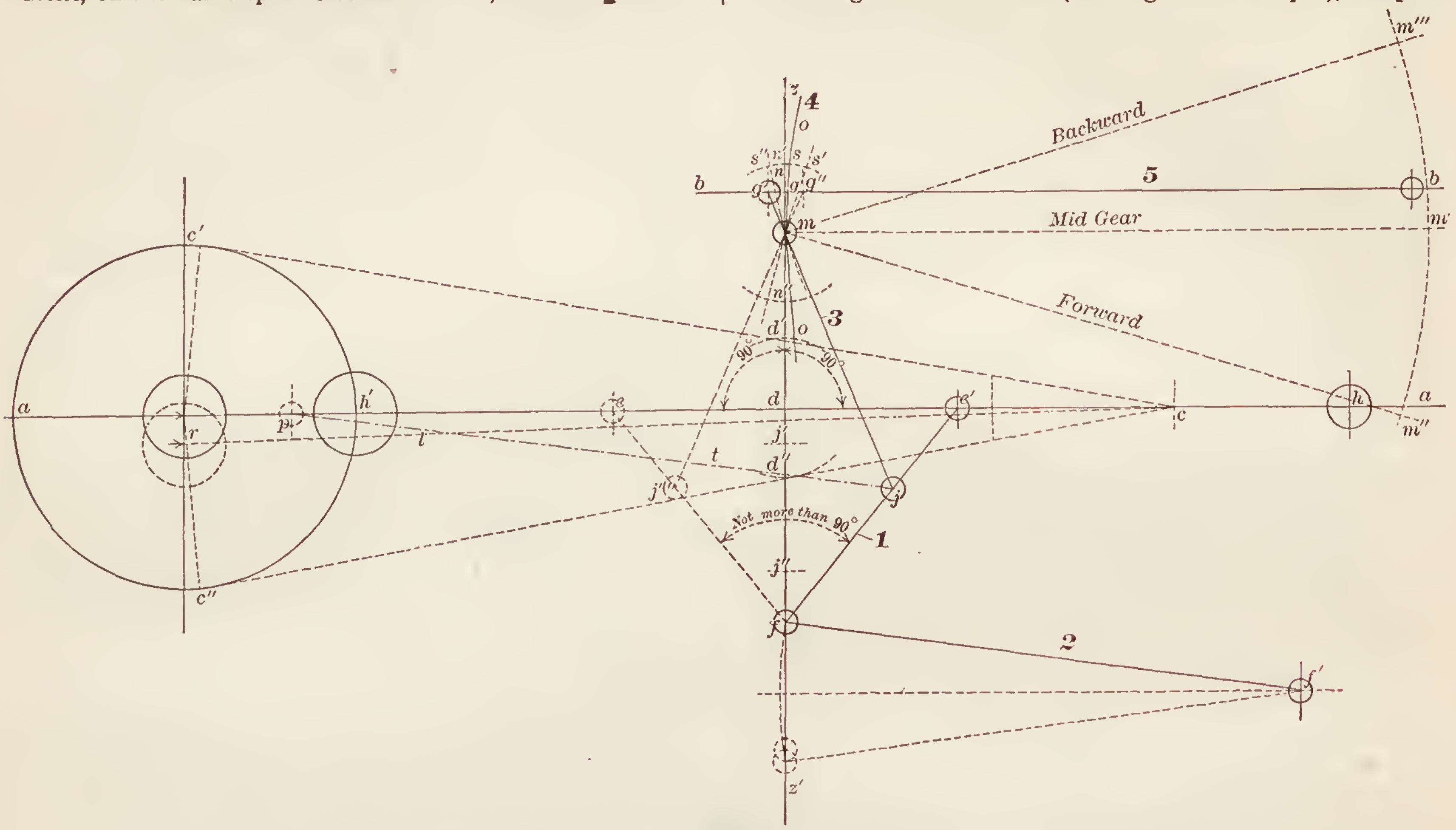


Fig. 3.

DIAGRAM FOR THE CONSTRUCTION OF THE JOY VALVE GEAR.

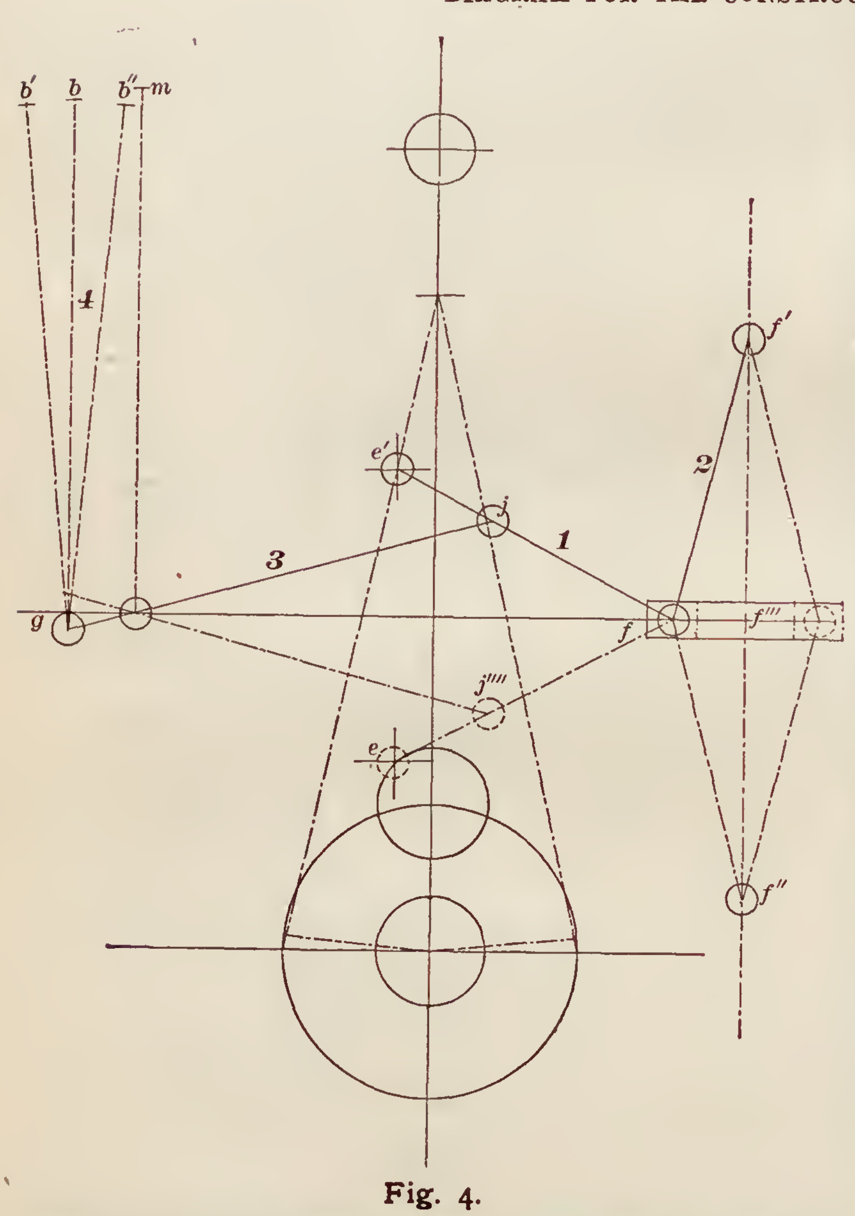


Fig. 4.

DIAGRAM FOR THE CONSTRUCTION OF THE JOY VALVE GEAR.

d, which we have chosen to take motion from, will be at e', and the connecting-link pinned to the connecting-rod for transmitting motion to the valve lever 3 will be at $e'\ f$. From a point, j, on this link, whose distance from e' has at first to be assumed, and will be about one-third more than $d'\ d$, the half vibration $d\ d'$ of the connecting-rod, draw the centre line of the lever 3 (see also figs. 1 and 4), actuating the valve, that is, joining j and g'; the point where this line crosses the vertical $z\ z'$ will be the centre or fulcrum of the lever 3, and will also be the centre of oscillation of the curved links 4 (fig. 1), in which the blocks carrying the centre of the lever slide; this centre is marked m, and stands for both centres, which must be concentric at each end of the stroke. The function of the link $e'\ f$, and the attachment of the valve lever to it at j, is to eliminate the error in vibration of the lever centre m, which would otherwise arise, from the fact that the path through which the lower end j of the lever 3 moves is an arc of a circle about the fulcrum m, and not a straight line. As the link 1 vibrates about the pivot e', the point j also describes an arc of a circle about e' as a centre. The position of these two arcs is reversed in relation to each other, and thus the movement of the link 1 neutralizes the error due to the movement of the lower end of the lever 3. Although the position of the point j may be found by calculation, it is much more quickly found by a tentative process, and to test if the assumed point j be the correct one, we mark off on each side of m vertically the correct equal vibration $m\ n'$ and $m\ n''$, required, which will be the same as the vibration $d'\ d''$ of the connecting-rod on the vertical line $z\ z'$. Then from d', the intersection of the centre line of the connecting-rod, when it is in the position $c\ c'$ with the vertical line $z\ z'$, lay off a distance, $d\ j$, equal to $e'\ j$ on the vertical $z\ z'$, and from d'', the intersection of the centre line of the connecting-rod, when it is in the position $c\ c''$ with the vertical $z\ z'$, lay off a distance, $d''\ j''$, also equal to $e'\ j$. Then, if the length $j\ m$ be applied to $j'\ n'$ (measuring from j') and to $j''\ n''$ (measuring from j'') and the point m fall below n' and n'' in each case, it will be necessary to take a point on $e'\ f$ higher than j; or if, on the other hand, m falls above n' and n'', then a point must be taken on $e'\ f$ lower than j. This point will generally be found on a second trial, but the length $j\ m$ of the lever $j\ m\ g'$ must be such that its centre m vibrates equally above and below the centre of the quadrant, also marked m.

The point m, as said, now represents the centre of oscillation for the curved links 4 and the centre or fulcrum of the lever 3. And these, as already said, must coincide, when the piston is at each end of the stroke, the lead being then fixed, and the curved links can be pulled over from forward to back-

ward or any point of expansion without altering the lead. This may be taken as a test of the gear being set out correctly.

The point *g* will be the point of attachment for the valve spindle link marked 5 (see also figs. 1 and 2), which may be made any convenient length, but from that length as a radius the curve of the links must be drawn from a centre, *m'*, on the parallel line *m m'* ; the angle at which this curve is set from the vertical (which is mid-gear) will give forward or backward gear—the angle leaning forward *s'*, or to the front of the engine, being forward gear, and the reverse *s''* being backward gear. The centres for these curves will be found at *m''* and *m'''*. The amount of the angle marked on the curve of extreme vibration at *s s'* or *s s''* will be equal to one-quarter more than the full opening of the port at that angle (that is, if 1'' opening of port be required, then the amount of the angle *s s'* must be 1¼''), and the point of cut-off will be about 75 per cent. Laid out in this form the "leads" and "cut-offs" for both ends of the cylinder, and for backward and forward going, will be practically perfect and equal, and the opening of ports also as near as possible equal. If a longer "cut-off" than 75 per cent. is required, it is only necessary to increase the angle of the curve link *o o* beyond *s'* for forward gear, or beyond *s''* for backward gear. It will be noticed that in this gear the "lap" and "lead" are entirely dependent on the action of the lever *j m g'* as a lever, and may be varied according to the length of *m g'*. And the opening of the port (beyond the amount given as lead) is dependent on the amount of angle imparted to the curved link *o o*, and will be, as above said, about four-fifths of the amount of that angle from the vertical, measured on the line of extreme vibration.

Instead, however, of employing a curved link with slide blocks to guide the centre or fulcrum of the lever 3, this centre may be hung in sling links, having their centres of suspension adjustable in the curve *m' m'' m'''*, such centres of suspension representing the points for "midgear," "backward," and "forward" going. All the rules for laying out the gear will, however, remain the same.

Deviations from the above positions and proportions may be made without materially altering the correctness of the results.

Thus, if it is found necessary to raise or lower the centre *m*, to clear wheels, frames, or other gear, without altering the position of the valve spindle centre, this may be done till the angle of *m m'* is out of the parallel of the cylinder centre line up or down by one in thirteen ; it is not well to go beyond this, but the lines *m m'* and *b b* will be parallel, and the position of the curve *o o*, which is the centre line of the curved links, for mid-gear will be at right angles to *m m'*.

Again, the point *e'* may be taken either above or below the centre line of the connecting-rod if it be wished to avoid piercing the rod, the pin at *e'* being carried in a small bush or block attached above or below the connecting-rod, or to a boss forged on the connecting-rod.

Again, for locomotives, if the wheels are so small that the link *e' f* would come too low, it may be cut short at the point *j*, and this point connected by a link, *l l*, to a small return crank, *p*, on the crank-pin, the movement of the counter-crank being equal to that from *j* to *j''''*.

The diagram is drawn for an engine where the centre of the crank axle is on the centre line of the cylinder, but if this be below, as is usual in American locomotives, then the base line on which to construct the diagram of the valve gear itself will be the average centre line assumed by the connecting-rod for such lowering of the crank axle centre, drawn from *c*, the middle position, to a point, say *r*, representing the lowered centre of the axle. The vertical *z z* will be at right angles to this new base line, *c r*, all the other processes following.

For vertical engines the same rules apply, by placing the diagram vertically and altering relatively the terms "vertical" and "horizontal."

While the proportions shown on the diagram give the best average results, these proportions may be varied within very wide limits, according to the requirements of the design of the engine. Thus, when the distance between the centre of the cylinder and centre of valve spindle is small, as with a small cylinder and a long stroke, the link *e' f* may be considerably lengthened ; the point *j* will thus be dropped, and convenient angles for all the links, etc., will be maintained, the room for the various movements being got below the centre line of the cylinder, when it cannot be had above.

In marine engines the reverse conditions are usual, the distance between the cylinder and valve spindle centres being abundant, and very little room available behind the engine. In this case the point *e'* may be taken out of the centre line of the connecting-rod (see fig. 4), so bringing all the gear so much further forward. The end of the link 1 may then be swung at *f* by the link 2 centred either above, as at *f'*, or below, as at *f''*, or it may be carried in a cross-slide, *f'''*.

Also to accommodate the centre lines of the valve spindles of the high and low-pressure cylinders (if different), one centre may be carried outward to *b'* and the other inward to *b''*, from the normal centre line *b'* ; this angle may be as much as one in twelve without affecting the accuracy of the gear. The centre line of the quadrant at mid-gear will, however, be always at right angles to the altered vertical centre line. In all cases it is well to keep the levers and links as long and the angles as easy as the room at disposal will allow.

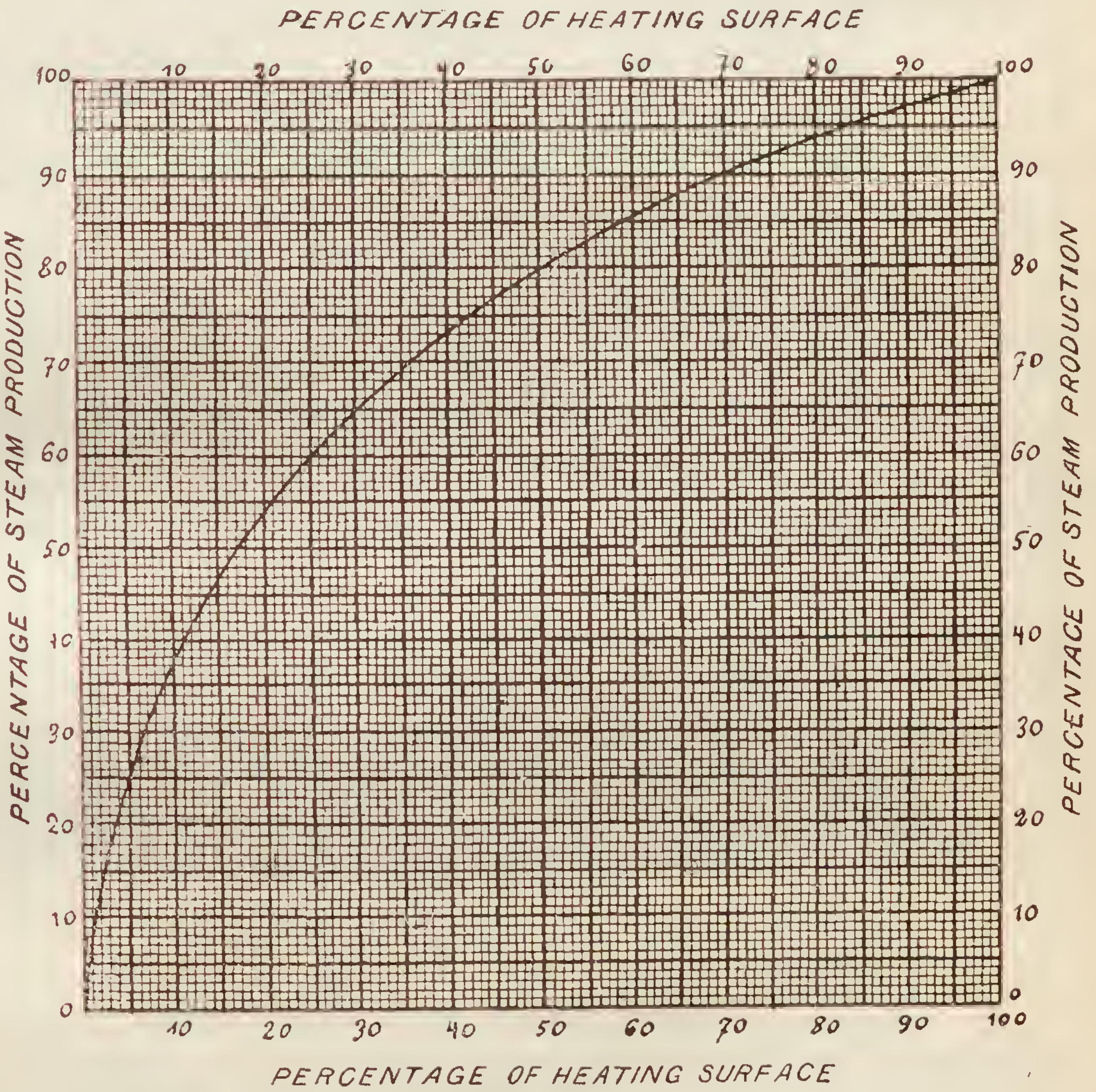


Fig. 1.

STEAM CURVE FOR LOCOMOTIVE BOILERS, ACCORDING TO COUCHÉ.

THE DETERIORATION OF LOCOMOTIVE AND MARINE BOILERS DUE TO EXPANSION, AND THE MEANS OF LESSENING THE SAME.*

By Herr Lentz.

It is well known that when a boiler is heated it expands, and that its dimensions change. These conditions have, up to the present time, not been demonstrated with sufficient clearness

* Paper read before the *Verein für Eisenbahnkunde.*

to enable us to reach a conclusion as to the defects existing in each boiler, and lead us to a more rational method of construction. Also the diminished factor of safety and the low limit of elasticity in the high-pressure boilers receive but little attention. I will, therefore, straightway show you the observations and calculations which I have made regarding these expansions that result from the heating, and then elucidate the conclusions which I have deduced therefrom.

We find in the fire-boxes of locomotives and other boilers certain deformations that are for the most part due to the difference in temperatures of the several parts and the slight elasticity existing between them, and which offer the means for the application of methods for obviating the difficulties that have as yet received but a limited adoption.

Deformations have also been found in the nests of tubes of stationary and marine boilers, as well as in those of locomotives, without the prevailing changes which are the root of the whole evil being thoroughly examined.

which gives the heating surface and steam production in percentages, so that if we know what percentage of the total heating surface is to be found in the fire-box, we can straightway read the percentage of total steam production that is to be attributed to it.

We also see, from this curve, how rapidly the steam production of the tubes falls off at the smoke-box end. For example, in the first 10 per cent. of the heating surface 38 per cent. of the evaporation is accomplished, while in the last 30 per cent. only 10 per cent. is done. Thereby we can calculate how many pounds of water is evaporated per square foot of fire-box heating surface, and how many for that of the tubes.

In order to determine the mean temperature of the sheet from the steam production per square foot of heating surface, we can avail ourselves of the table (fig. 2) of Hirsch, which was first published in the *Annales du Conservatoire des Arts et Metiers*, at Paris in 1889.* In the vertical columns the mean temperature of the sheet in degrees Fahrenheit and Centigrade

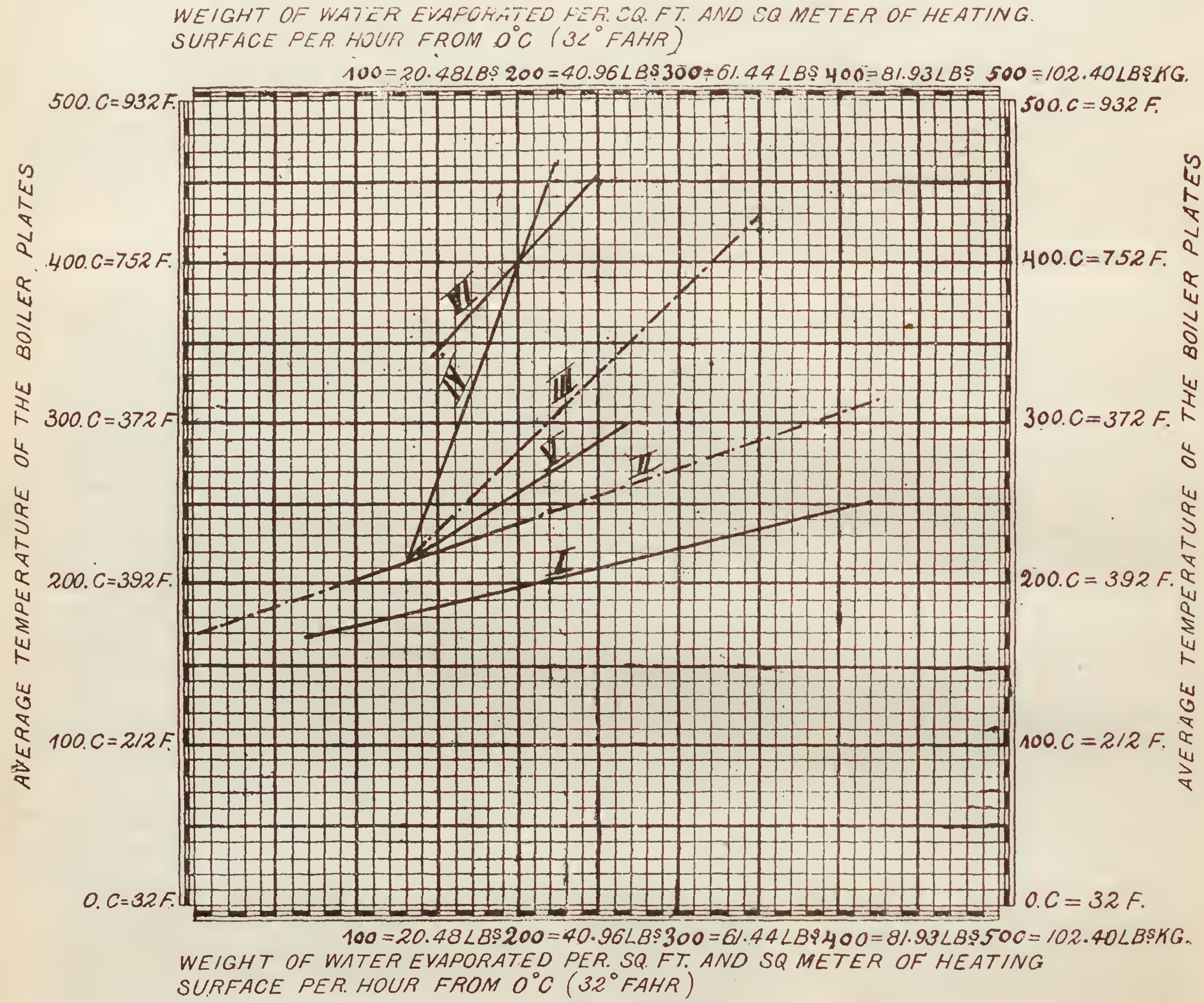


Fig. 2.

GRAPHICAL REPRESENTATION OF HIRSCH'S INVESTIGATIONS.

In order to ascertain the exact mass of a plate expanded by contact with the fire we must know its mean temperature, and in order to determine this we must know the amount of heat that it imparts to the water and how much water it evaporates per square foot of heating surface per hour. In order to get this it is necessary to know the total amount of steam generated in the boiler per hour.

Experiments have frequently been made to determine with great accuracy the evaporative efficiency of locomotive boilers, so that for a given machine it is easy to fix the number of pounds of water that the boiler will evaporate per hour.

It must then be ascertained how much is evaporated by the fire-box and how much by the tubes. In this connection the investigations of Messrs. Geoffroy and Delebecque of the Northern Railway of France, and which were published by Couché in his work, are of the highest value.

From these investigations I have plotted a curve (fig. 1) is given, while in the horizontal lines are the weights of water that are evaporated in pounds per square foot and kilograms per square metre of heating surface.

Hirsch carried on his experiments in determining the mean temperature of the plates by means of various fusible plugs having different melting-points, and thus plotted the lines that are given. The lowest line, I, is for a clean upper surface of the sheet and distilled water, so that the temperature of the sheet is quite low. Line II is for a sheet that was covered with a scale .04 in. thick, and line IV for one where the scale was .2 in. thick.

Hence it appears to me that if we take .04 in. for the thinnest layer of scale and .2 in. for the thickest, we may safely take .12 in. as the average, and by bisecting the angle between

* The table published in fig. 2 is modified from the one actually published by Hirsch, which read in kilograms, square metres and degrees Centigrade, o read in pounds, square feet and degrees Fahr.—Ed.

the lines II and III obtain the line IV, which may be assumed as representing a fair average to be adopted in our calculations.

Line V is for a sheet covered with mineral oil, and line VI for a double sheet with an interposed layer of tallow .004 in. thick.

Although these experiments were made with iron boiler plates, yet when there is a layer of scale .12 in. thick the difference in the evaporative efficiency between iron and copper will be so slight that, in what follows, the line III will be considered as exceeding the average.

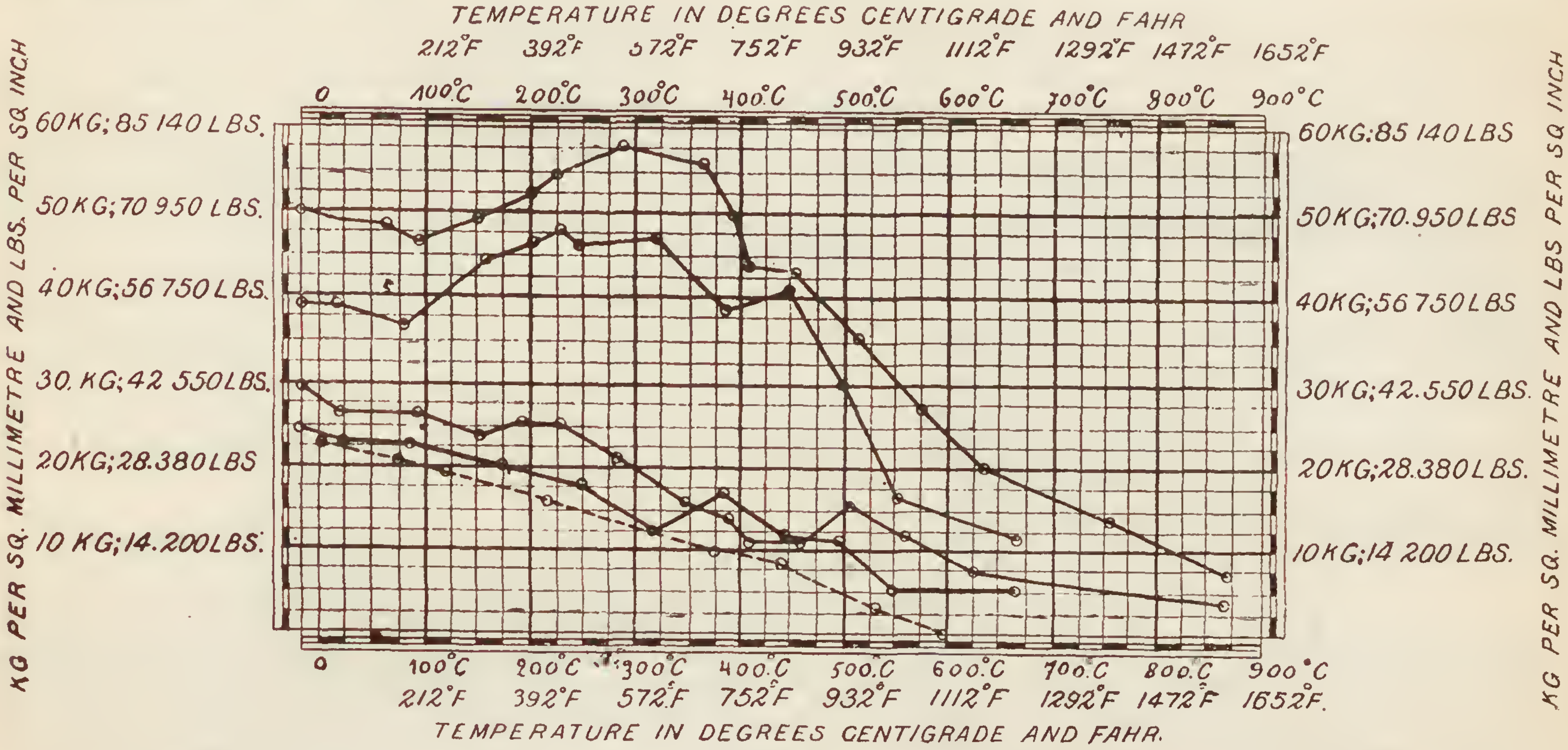


Fig. 3.

DIAGRAM OF THE TENSILE STRENGTH AND LIMIT OF ELASTICITY OF STEEL, WROUGHT IRON, AND COPPER.

Hirsch made his experiments on evaporative efficiency with the valve open, and at 212° F.; to the figures that have been found, therefore, about 180° F. (100° C.) must be added.

For example, suppose there are 45 lbs. of water evaporated at a pressure of 12 atmospheres from each square foot of heating surface per hour, wherein the temperature of the steam is 375° F.; with pure water and a clean plate the temperature of the plate becomes 400 + 160 = 560° F.; with .04 in. of scale, 470 + 160 = 630° F.; with .12 in. of scale, 570 + 160 = 730° F.; and for .2 in. of scale, 840 + 160 = 1,000° F., which would be in the highest degree dangerous for copper, since, according to fig. 3, it has at that point a tensile strength of only about 1,950 lbs. per square inch, while a copper crown-sheet will lay claim to a shearing strength of the stay-bolt heads for a steam pressure of 12 atmospheres, and even be grooved above the stay-bolts. And .2 in. of scale is not uncommon on a copper crown-sheet.

From the ascertained temperature we are now to calculate the expansion, which I take to be $\frac{1}{850}$ for wrought iron and $\frac{1}{580}$ for copper for each 180° F. or 100° C., or $\frac{1}{1710}$ and $\frac{1}{1044}$ per 100° F. respectively. If we have now calculated the tension resulting from expansion, fig. 3 will serve to tell us whether the limit of elasticity or tensile strength has been exceeded by the corresponding temperature. The two upper lines represent the tensile strengths of steel and wrought iron; the next two, the limits of elasticity of the same, according to the experiments made by the Navy Department of the United States, and it is interesting to note that while the tensile strength is the highest at about 575° F., the limit of elasticity drops continuously. The lower dotted line gives the tensile strength of copper, which drops to zero at about 1,110° F.

Let us now take for an example our new four-wheels coupled high speed locomotive (fig. 4), where we have observed the expansions lengthwise, across and vertically.

According to the investigations of the Messrs. Lochner * at Erfurt, the boiler, which only differs slightly from the so-called Erfurt boilers, evaporates from 12,000 lbs. to 19,800 lbs. of water per hour at a steam pressure of 12 atmospheres, and when running at a speed of from 31 miles to 56 miles in the same time. Suppose we take for the following estimate only 15,400 lbs. of steam produced per hour, and take the fire-box as having 97 sq. ft. of heating surface, and the tubes 1,184 sq ft., giving 7½ per cent. of the total heating surface to the first, and 92½ per cent to the tubes. It will be seen, then, that, according to fig. 1, the fire-box will evaporate 32 per cent. of

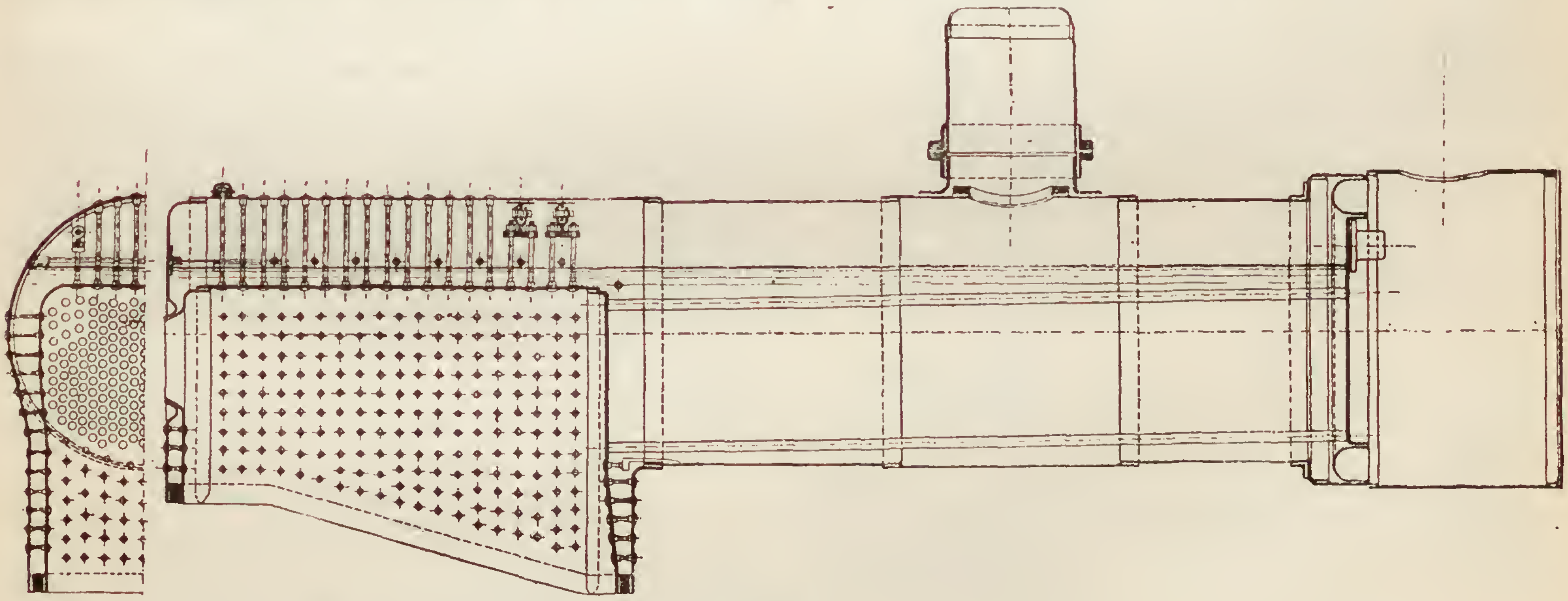


Fig. 4.

BOILER FOR EXPRESS PASSENGER LOCOMOTIVE ON THE STATE RAILWAY OF HANOVER.

* *Organ für die Fortschritte des Eisenbahnwesens*, 1894, vol. xxi., Nos. 3 and 4, page 108.

the 15,400 lbs. or 4,928 lbs., and so for a heating surface of 97 sq. ft. the rate of evaporation is 50.8 lbs. per square foot. For the tubes the same calculation gives 8.84 lbs. per square foot of heating surface of the tubes.

According to fig. 2 we find that for the fire-box 630 + 160 = 720° F., and for the tubes 360 + 160 = 520° F. expresses the average temperature of the material, from which we can obtain the expansion of the several parts ; hence we have :

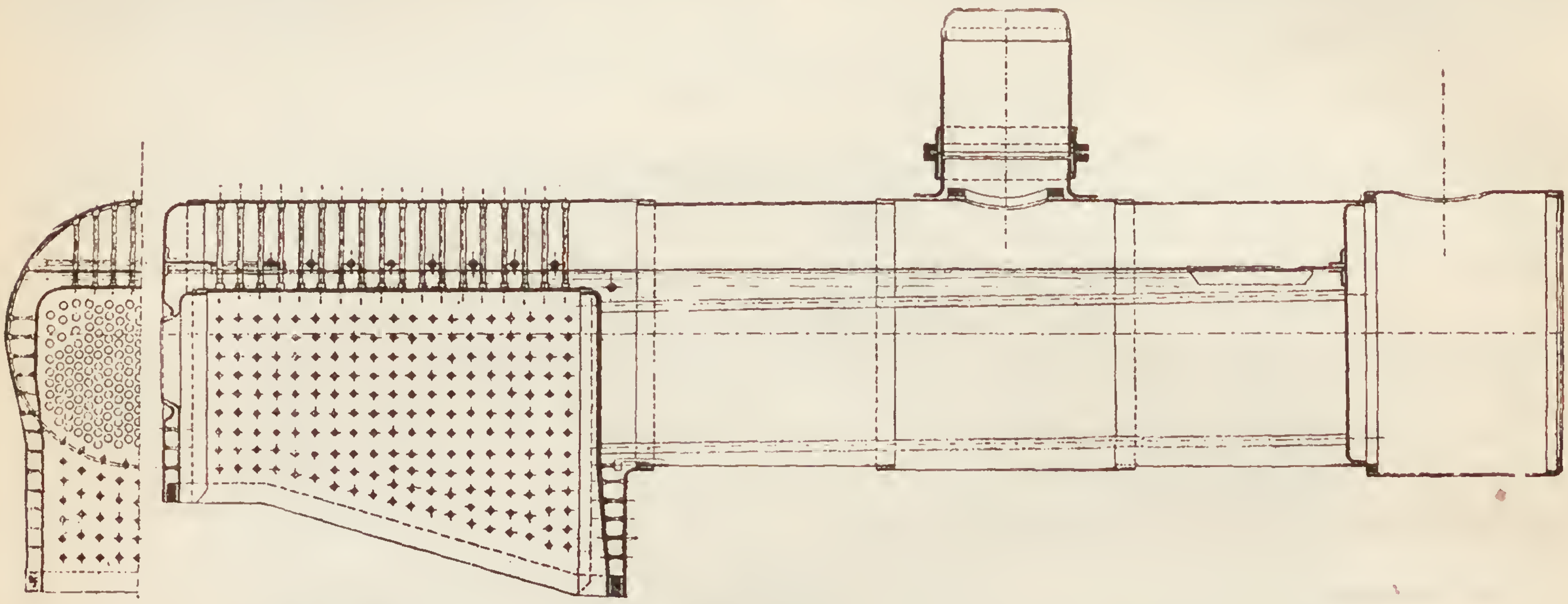


Fig. 5.

LOCOMOTIVE BOILER WITH FLEXIBLE TUBE-SHEET AND SELF-ADJUSTING STAYBOLTS.

For the stay-bolts, $\frac{1}{1044} \times 2.67 \times 3\ 7 = 0.0094$ in.
" " fire-box, $\frac{1}{1044} \times 88.3 \times 7.2 = 0.6089$ "
" " tubes, $\frac{1}{1710} \times 153.55 \times 5.2 = 0.4675$ "

Total........................ 1.0858 "

The temperature of the outer shell is practically within 5 per cent. of the temperature of the water, which in this case amounts to 351½°, and we calculate the expansion of the outer shell therefrom as

$$\frac{1}{1710} \times 244.52 \times 3.515 = .5025 \text{ in.}$$

The expansion of the inner portion is therefore .5835 in. greater than the outer. But the latter will also be stretched

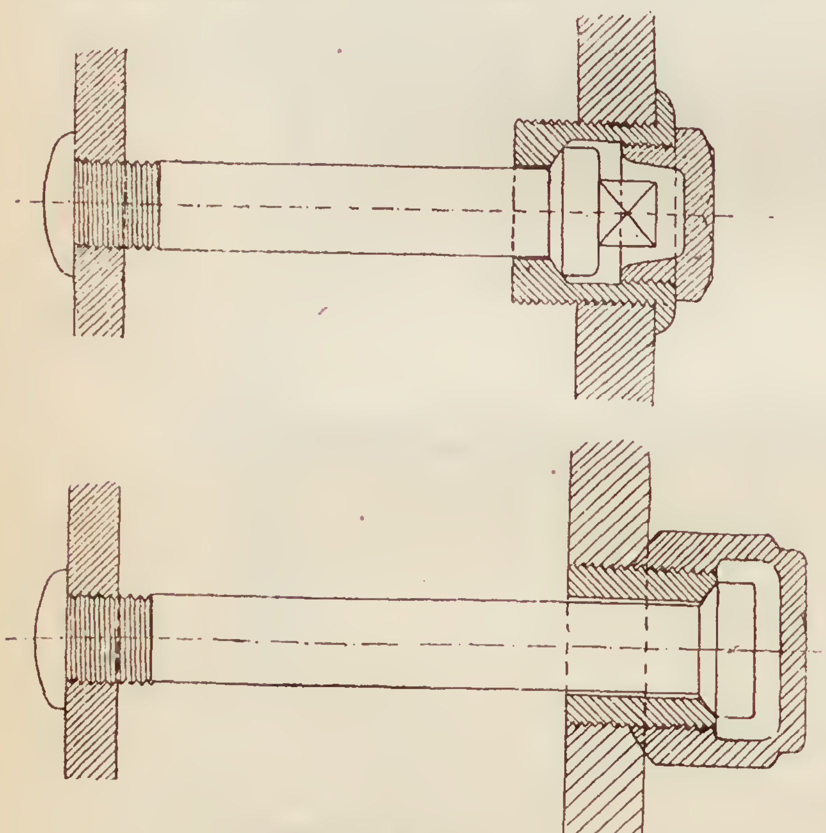


Fig. 6.

CONSTRUCTION OF SELF-ADJUSTING STAYBOLTS.

in the same direction by about .0366 in., so that the total expansion of the inner shell is .5469 in., or, in round numbers, about .55 in. more than the outer.

The extension of the outer shell through the steam pressure acting longitudinally resolves itself into a drawing out of the metal, which for a modulus of elasticity of 12,900,000 becomes in this case

$$\frac{1935 \times 244.52}{12{,}900{,}000} = .0366 \text{ in.}$$

The tubes will now press against the tube-sheets in order to make up for this .55 in., and if they are but slightly compressed in their length as well as sprung a little out of line, and the strong tube sheet of the smoke-box sprung a little as well as the copper fire-box compressed a trifle lengthwise, there will still remain about .38 in., which will probably be taken up by the pressing back of the tube-sheet as well as the back head of the boiler. The result is that a fracture frequently occurs in the flanging of the back head.

The tubes are pushed with great force against the tube-sheets as a result of these expansions, and are often shoved through the one at the fire box end ; yet when this is made fast with a shoulder it frequently happens that it is pushed through at the smoke-box end. As a general thing the tubes remain tight in the latter, for the temperature is not so high at this point, while at the fire-box end, where the temperature of the tube-sheet is the highest, averaging about 90° F. higher than the average temperature of the fire-box, the copper, which is used for tightening the tubes, will be stretched beyond its limit of elasticity, and will not return to its normal position, so that the expansion of the tube will cause it to yield, the ends will be pushed through, and a considerable play of the tubes is the unavoidable result.

Now, if a flexible tube-sheet is used, as is shown in fig. 5, the steam pressure acts upon this elastic ring and presses out the tube-sheet several millimetres, so that the expansion of the tubes and a portion of that of the fire-box is taken up, so the tubes remain perfectly tight and yet free to expand in the boiler, and there is room for the movement and action of the tubes to take place, while the fire-box tube sheet will no longer be pushed back, the strain on the back sheet of the fire-box will be greatly modified and the stay-bolts will be able to work normally.

When there is a steam-pipe lying inside the boiler, as in the foregoing construction, a stuffing-box must be placed in the movable tube-sheet. In the cross section of the fire-box the difference in the expansion of the inner and outer shell is but slight, and at the widest part may be taken to be about as follows :

Two stay-bolts = 0.04 in. expansion.
Copper fire-box = 0.32 " "

Total......... 0 36 " "

From which we take the expansion of the outer shell, which is 0.11 in., leaving an excess of .25 in., and also the excess on the side sheets only acts injuriously upon the front and back vertical rows of bolts. Here comes in the desirability of using stay-bolts that have a flexible attachment, by which the angularity caused by the unequal expansion may be taken up, two constructions of which are shown in fig. 6. The upper horizontal row of stay-bolts sustains its greatest angular bending at the inner shell of the fire-box, as shown in figs. 4 and 5 ; it is very slight, but the short radius to which they are bent makes a row of movable stay-bolts very desirable at this point.

The vertical expansion of the fire-box shows a still greater difference. In the foregoing instances it is comparatively

slight on the back end, where the height is only a trifle more than 3 ft. and the temperature is consideraly below the average. But they should be used in deep fire-boxes, where the back axle does not come below the grates, as in the English engines. In these boilers the movements have the same unfavorable tendencies as at the tube-sheets, and a good construction of the door opening is necessary, as is shown in the preceding case, where the stiff door rings are avoided; and although there is a cooling of the water, a certain elasticity is obtained and the slight vertical motion provided for.

The temperature of the tube-sheet is somewhat higher than the average temperature of the fire box, the minimum being 840° F., and when there is a thick deposit of scale it may rise as high as 930° F. At 840°, and with a tube-sheet 57 in. high, the expansion will be $\frac{7}{16}$ in. and $\frac{1}{8}$ in. for the outer shell, leaving a variation of $\frac{5}{16}$ in. In order that this movement of $\frac{5}{16}$ in. may take place and the fire-box rise, the copper must be bent upward ahead of the front row of stays, provided the latter are stiff and rigid.

When we consider the similar and coincident horizontal pressure of the tubes and the vertical thrust of the braces upon the tube-sheet, it is astonishing that the copper sheet lasts as long as it does before breaking at the flanging when subjected to this maltreatment.

(TO BE CONTINUED.)

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

THE object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publications will in time indicate some of the causes of accidents of this kind, and to help lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with the information which will help make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a great favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in January, has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS IN JANUARY.

Galion, O., January 1.—There was a collision at Yorktown, on the Big Four Railroad, this morning between two freight trains, in which W. A. Shull, an engineer, and Joshua Walsh, a fireman, were killed, and Charles Sutton, an engineer, and Henry Hurst, a fireman, were badly injured.

Fort Worth, Tex., January 1.—Silas S. Melson, a fireman on the Texas & Pacific Railroad, was badly hurt by falling under his engine at Forney this evening. His left hand and left foot were injured, and he is supposed to be internally injured.

Philadelphia, Pa., January 1.—A collision occurred at Wingohocking, on the Philadelphia & Reading Railroad, this evening between two passenger trains, in which Engineer Snyder was injured. The collision was caused by a misplaced switch.

Bainbridge, O., January 2.—Owing to a misunderstanding of orders, a collision occurred between two freight trains on the Ohio Southern Railroad to day. Fireman Charles Snyder was instantly killed, his neck being broken; Engineer William Hayes had his leg broken; Engineer Burt Simmons was badly hurt about the head and legs, and Fireman Charles Crawford was badly hurt on the right side.

Greenville, Tex., January 5.—William Greenlee, an engineer on the Missouri, Kansas & Texas Railroad, was struck by a switching engine here to-day. His right leg was so badly crushed that he will die from the effects of his injuries.

San Francisco, Cal., January 5.—An express train on the Southern Pacific Railroad collided with a work train in the Altamont Tunnel to-day. The fireman of the express was killed outright, and the engineer was so fearfully mangled that he died from his injuries. Both trains had been informed that they had the right of way.

Wellsboro, Pa., January 5.—A fast freight train on the Fall Brook Railroad jumped the track near Middleburg this morning, and Engineer McQuade was pinned beneath the wreck. It was 20 minutes before he could be released, when it was found that his legs, back and right arm had been literally cooked by the escaping steam, and that his body was frozen, the thermometer being 20° below zero. He was alive when released, but died from his injuries.

Cleveland, O., January 7.—A head-end collision occurred on the Wheeling & Lake Erie Railroad near Smithville to-day. Fireman J. W. Walker was caught in his cab and roasted to death. Engineers Burkhart and Burns were badly though not fatally hurt. One of the firemen is missing.

Falls City, Neb., January 8.—William Rowley, an engineer on the Chicago, Burlington & Quincy Railroad, was run over this afternoon, and had both legs cut off. He died shortly afterward.

Chattanooga, Tenn., January 8.—A passenger train on the Queen & Crescent Route was wrecked by an open switch at Attalla to-night. Fireman Roy Johnson was killed by falling under the engine, and the engineer had his arm badly bruised and broken.

Brooklyn, N. Y., January 10.—An engine on the Kings County Elevated Railroad got beyond the control of the engineer this evening, and crashed through the bumper at the end of the rails. The engine went to the street, and pinned the fireman beneath it. He was rescued after some time, but was so badly injured that he died. The engineer jumped just before the engine struck the ground and escaped with a broken leg and a fractured frontal bone. He is expected to recover.

Pittsburgh, Pa., January 11.—A rear-end collision occurred on the Pennsylvania Railroad at Versailles this evening. The engineer and fireman jumped, the former sustaining a bad sprain of the knee. The accident was caused by the breaking in two of the leading train.

Kansas City, Mo., January 11.—A switch engine in the Hannibal & St. Joseph yards collided with a Wabash passenger train to-day. Engineer C. W. Olman was killed and Fireman J. R. Nettles fatally injured.

Logansport, Ind., January 12.—A freight train on the Pan Handle Line was thrown from the track here to-day by a switch becoming filled with and packed with snow and ice. Fireman S. G. Lucas was badly hurt.

Milwaukee, Wis., January 12.—There was a collision between a light engine and a freight train on the Chicago, Milwaukee & St. Paul Railroad at North Avenue Station this morning. Engineer Zolowiez, of the switch engine, had his arm and leg broken.

Indianapolis, Ind., January 13.—A passenger and freight train on the Indiana, Decatur & Western Railroad collided 45 miles west of here this morning. William Fletcher, engineer of the passenger train, was killed.

Las Vegas, N. M., January 14.—A freight train on the Atchison, Topeka & Santa Fé Railroad ran into an open switch east of here this morning. Fireman Dodson and Engineer Collins were fatally injured, the latter being scalded.

Kansas City, Mo., January 15.—Engineer Myers, of the Atchison, Topeka & Santa Fé Railroad, fell into a cinder pit this afternoon and was severely hurt about the side.

Boston, Mass., January 15.—An engine and three cars of a freight train on the New York & New England Railroad plunged into an open drawbridge at South Boston to-night. The fireman escaped by jumping, but the engineer was carried down with the engine and buried beneath the wreck.

Reno, Nev., January 17.—A passenger train on the Southern Pacific Railroad ran into an open switch at Wadsworth this morning, and was wrecked. The engineer was seriously hurt, as was the fireman also.

Massillon, O., January 17.—A head-end collision took place on the Wheeling & Lake Erie Railroad to-day. Fireman Ryan was badly injured.

Bloomington, Ill., January 21.—Philip Neuhaus, a fireman on the Illinois Central Railroad, fell from his engine this morning and sustained a concussion of the brain, from which he died in a short time.

Bradford, Pa., January 22.—Three sections of a freight train on the Buffalo, Rochester & Pittsburgh Railroad were running close to each other near here to-day, when the second section was obliged to slow up. The flagman did not have time to signal the third section before it crashed into the second. Fireman William Baxter had his arm so badly crushed that it had to be amputated.

Mt. Airy, Ga., January 24.—A freight train on the Southern Railway ran into a landslide near this place this morning. Fireman Harry Wooten was injured, but not seriously.

Columbus, S. C., January 25.—Train wreckers wrecked a passenger train on the Southern Railroad near Moorhead, Miss., this morning. Engineer Graham Jones and Fireman Harvey Woods were caught under the engine and terribly scalded.

Bridgeport, Conn., January 26.—G. Frank Northrop, a fireman on the Consolidated Railroad, was struck on the head by the Park Avenue Bridge this afternoon and killed.

LOCOMOTIVE RETURNS FOR THE MONTH OF NOVEMBER, 1894.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage.					Av. Train.		Coal Burned per Mile.						Cost per Locomotive Mile.							Cost per Car Mile.		Cost of Coal per Ton.
			Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Passenger Cars.	Freight Cars.	Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Passenger.	Freight.	
										Lbs.	Lbs	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Atchison, Topeka & Santa Fé	864	789	....	....	292,240	2,064,242	2,701	....	....	....	....	....	84.21	....	..	3.80	7.15	0.26	0 20	6.79	1.21	19.41	..	...	1.62
Canadian Pacific	609	....	466,783	796,824	259,579	1,525,066	2,504	...	....	....	....	..	76.22	....	....	3.85	11.00	0.19	....	5.75	1.27	22.06	1.86	....	2.02
Chicago, Burlington & Quincy	....	....	....	....	....	....	...	....	....	..	....	....	....	....	....	....	....	....	....	...	....	...	....	....	....
Chicago, Milwaukee & St. Paul	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Chicago, Rock Island & Pacific	....	....	457,076	817,641	353,524	1,628,241	....	5.40	18.20	59.06	79.27	45.52	68.00	11.00	4.77	2.77	6.59	0.20	....	6.04	0.52	16.12	....	....	2.06
Chicago & Northwestern	1010	....	774,215	1,383,904	613,858	2,771,977	....	....	...	....	...	....	94.34	.. .	....	3.18	8.20	0.27	....	6.27	0.82	18.74	....	....	1.73
Cincinnati Southern	....	....	....	....	....	..		....	....		....	....	....	....	...	....	...		...	....	....	....	...	....	....
Cumberland & Penn.*	..	23	5,617	37,320	....	42,937	1,866	..	..	....	....	....	86.39	....	....	6.78	4.67	0.32	....	...	1.61	13.38	...	....	.. .
Delaware, Lackawanna & W. Main L.	213	195	70,070	598,656	....	668,726	3,429	....	.. .	...	...	....	85.10	....	....	3.17	6.21	0.38	....	5.77	....	15 53	....	....	1.46
Morris & Essex Division	162	..	179,891	228,671	11,087	419,649	....	....	....	...	...	...	69.51	....	....	3.57	10.83	0.34	..	7.10	....	21.84	....	...	3.09
Flint & Père Marquette	....	....	84,235	77,852	45,311	207.398	2,469	....	....	52.21	100.19	41.13	70.06	..	....	3.18	6.49	0.11	0.04	5.01	0.99	15 82	....	....	1.77
Hannibal & St. Joseph	...	....	64,933	132,009	34,236	231,026	3,500	5.13	17.60	....	....	....	87.22	13.71	6.43	2.31	6.86	0.13	0.42	6.99	....	16.71	....	..	1.57
Kansas City, Ft. S. & Memphis	140	....	93,179	187,887	88.782	369.848	3,056	...	....	....	....	....	72.20	..	....	2.73	5.15	0.25	0.41	7.34	....	15 93	....	...	1.40
Kan. City, Mem. & Birm	42	37	34,865	55,756	10,925	101,516	2.744	...	...	...	....	..	68.94	....	....	3.43	3.24	0 19	0.27	6.68	....	13 81	....	...	0.93
Kan. City, St. Jo. & Council Bluffs	38	36	49,829	33,327	38,007	121,163	3,275	5.13	19.81	....	....	....	73.83	15.12	4 83	3.78	6.22	0.14	0.64	6.81	. ..	17.61	...	...	1.59
Lake Shore & Mich. Southern	590	...	368,739	861,989	438.523	1,668,251	2,947	....	....	67.20	91.74	47.22	73.55	....	...	2.78	5.44	0.10	0.07	6.94	0.11	15.44	...	...	1.47
Louisville & Nashville	.. .	..	....	....	....	....	.. .	....	...	..	..	....	....	...	...	..	....	....	...	....	....	...	..	....	....
Manhattan Elevated	....	298	734,223	....	65,195	799,418	....	....	....	....	....	...	43 73	....	....	2.50	8.50	0.20	0.50	9.40	...	21.10	....	....	4.01
Mexican Central	148	130	....	....	....	396,606	....	.	...	. . .	....	...	60.24	....	..	4.58	11.67	0.43	0.11	4.96	....	21.75	....	....	3.77
Minn., St. Paul & Sault Ste. Marie	....	....	....	....	....	....	....	....	...	....	....	....	...	....	4.59	....	....	....	....	...	....	....	...	....	....
Missouri Pacific	351	....	....	....	...	889,823	3,047	4.39	17.94	....	....	....	89.16	15.91	6 20	4.60	6.21	0.32	1.43	6.55	1.41	20.52	3.84	1.42	....
Mobile & Ohio	105	86	75,221	165,816	52,878	293,915	3,415	....	27.20	...	....	....	71.25	...	....	3.00	4.52	0.20	0.56	5.82	0.90	15.00	....	...	1.28
N. O. and Northeastern	....	....	....	....	....	....	....	...	....	....	....	....	....	....	....	..	....	....	....	...	....	....	....	...	.
N. Y., Lake Erie & Western	623	373	421,594	774,221	243,153	1,438,968	3,175	4.40	24.60	88.40	145.20	89.50	107.70	20.10	5.90	4.79	7.96	0.32	1.95	7.34	1.25	23.66	....	1.63	1.36
N. Y., N. H. & H., Old Colony Div.	....	....	....	....	....	....	...	...	....	...	....	....	...	....	....	....	...	....	....	....	....	...	....	....	...
N. Y., Pennsylvania & Ohio	289	156	121,911	402,360	146,025	670,296	3,361	5.40	18.90	90.20	133.30	95.90	106.46	16.70	7.00	4.17	6.86	0.29	2.25	7.03	1.06	21.66	....	1.76	1.17
Norfolk & Western, Gen. East. Div.†	....	...	92,445	304,836	53.512	450,793	2,716	5.10	21.30	47.45	107.81	....	77.63	9.30	6.08	5.69	3.88	0.26	....	...	....	9 83	....	...	3.50
General Western Division†	....	....	103,373	364,518	63,453	531,344	2,711	5.09	17.29	77.00	135.00	108.00	126.00	15.15	8.30	6.39	4.44	0.23	....	....	....	11.06	....	....	....
Ohio and Mississippi	....	.	....	....	....	....	....	...	..	....	....	....	....	....	...	....	....	....	....	...	....	...	....	....	....
Philadelphia & Reading	....	..	....	....	.... .	....	....	...	.	....	....	...	...	...	....	....	....	....	....	....	....	....	....	...	.. .
Southern Pacific, Pacific System	721	646	617,045	859,042	268,923	1,745,010	2,701	5.36	14.36	....	....	....	69.59	....	...	5.51	16.88	0.18	2.27	7.30	1.13	33.27	...	..	4.88
Union Pacific	704		396,358	876,003	269,502	1,541,863	3,497	6.26	20.45	.. .	....	....	116.08	15.26	7 69	7.10	9.50	0.40	....	9.64	1.00	25.64	3.92	1.65	1.63
Wabash	416	339	419,959	600,267	218,314	1,238.540	3,653	4.70	17.19	75.36	119.04	63.73	94.47	15.96	6.89	3.53	5.65	0.27	...	5 60	0.82	15.87	2.89	1.05	1.19
Wisconsin Central	149	110	134,814	169,992	75,178	379,984	....	. ..	....	....	....	....	87 95	....	....	2.71	7.20	0.15	....	6.42	0.78	17.26	....	....	1.63

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars. Empty cars which are reckoned as one loaded car are not given upon all of the official reports, from which the above table is compiled. The Union and Southern Pacific, and New York, New Haven & Hartford rate two empties as one loaded; the Kansas City, St. Joseph & Council Bluffs, and Hannibal & St. Joseph Railroads rate three empties as two loaded; and the Missouri Pacific and the Wabash Railroads rate five empties as three loaded, so the average may be taken as practically two empties to one loaded.

* Switching engines allowed 6 miles per hour; wood, construction and gravel trains, 10 miles per hour.

† Wages of engineers and firemen not included in cost.

Asheville, N. C., January 26.—A freight train on the Southern Railway ran into a rock slide near Salisbury this morning. Fireman W. L. Simmerson was killed.

Sutton, W. Va., January 26.—Engineer Lloyd Ohldester, employed on the West Virginia & Pittsburgh Railroad, fell beneath his engine to-day and was mangled and killed.

Winsted, Conn., January 28.—A freight train on the New York & New England Railroad left the rails at a point 2 miles west of here this afternoon. The engineer and fireman were injured. The wreck was caused by a brake shoe dropping from the car immediately behind the locomotive.

Syracuse, N. Y., January 31.—Henry R. Woolridge, a fireman on the Delaware, Lackawanna & Western Railroad, was badly injured this afternoon by falling from his engine while at work thereon.

Knox, Ind., January 31.—An engineer on the Indiana, Illinois & Iowa Railroad was severely injured in a rear-end collision that occurred at North Judson this afternoon.

Our report for January, it will be seen, includes 31 accidents, in which 10 engineers and 12 firemen were killed, and 15 engineers and 11 firemen were injured. The causes of the accidents may be classified as follows:

Collisions	11
Derailments	4
Falling from engine	4
Falling into cinder-pit	1
Landslides	2
Misplaced switches	4
Open draw-bridge	1
Run over	2
Struck by obstruction	1
Train wreckers	1
Total	31

General Notes.

The Foster Engineering Company, Newark, N. J., have just entered an order for two mammoth valves, 18 in. and 14 in. in size, intended for the Anheuser-Busch Brewing Association of St. Louis. These pressure regulators are of the Foster new "Class W" style, and when completed will be the largest reducing valves ever turned out of their works. Few if any pressure regulators of equal size are in service to-day.

The Abendroth & Root Manufacturing Company, 28 Cliff Street, New York City, sole makers of the Root improved water-tube boiler and Root's spiral riveted pipe, find business good, and state that the outlook for the ensuing year is "A No. 1." There has been a lively demand for their boilers from the South and West for service in electric lighting and street railway plants. This is a line of work for which the Root boiler is especially well adapted, and for which it has become deservedly popular.

Improvement in Battery Zincs.—The Brady Metal Company, 115 Borcel Building, New York, have been manufacturing for several years an improved crow foot zinc for battery purposes. They claim that it is a well-settled conclusion among electricians that if you reduce the internal resistance of the battery by bringing the zinc and copper near together it almost doubles the consumption of both zinc and vitriol. With this object in view, a short hanger pattern of the crow-foot battery zinc has been perfected, which they regard as a most decided improvement. The component parts of this zinc are an alloy of zinc and mercury, and it is further claimed that a number of practical tests recently concluded show the superiority of this kind of zinc.

The Brown Hoisting & Conveying Machine Company announce that they have purchased and added to their crane department the entire crane business of the Yale & Towne Manufacturing Company, of Stamford, Conn. The transfer occurred on December 1, 1894, and includes the manufacturing of all the travelling, locomotive, jib, pillar and other cranes, trolleys, tram-rails, etc., heretofore conducted by the Yale & Towne Manufacturing Company. This addition to their present extensive line of cranes and well-known hoisting and conveying machinery enables them to meet all the requirements and wants of customers in the line of electric, steam and hand-power cranes, as well as hoisting and conveying machinery, more completely than any other establishment in the United States. They are pleased to further announce that Mr. F. G. Tallman, 409 Times Building, Pittsburgh, Pa., who formerly represented the Yale & Towne Manufacturing Company in the crane business, will now represent this company, and give his personal attention to the sale of all the various machinery manufactured by them.

PERSONALS.

Clemens Herschel, Member Am. Soc. C. E., delivered a lecture, January 25, on The Measurement of Water before the students of the Rensselaer Polytechnic Institute at Troy, N. Y.

Robert Laidlaw, President of the Laidlaw-Dunn Gordon Pump Company, of Cincinnati, was elected Treasurer of the National Association of Manufacturers, which convened at Cincinnati the third week in January. Mr. Laidlaw was one of the leading spirits in organization of the Association, and much of the success of the convention was due to his superior executive skill and untiring energy.

OBITUARIES.

Eugene L. Maxwell.

Eugene Lafelle Maxwell, of the firm of Manning, Maxwell & Moore, of New York, President of the Pond Machine Tool Company, of the Ashcroft Manufacturing Company, and of the Shaw Electric Crane Company, died at his home in Brooklyn, on Saturday, February 9th. Mr. Maxwell was born in Brooklyn, and was 44 years old. The business of the well-known firm of which he was a member brought him in relations with a wide circle of acquaintances in various branches of mechanical engineering, among whom he was very popular and had achieved the enviable reputation of being a thoroughly honorable and a very courteous gentleman, a true friend, and a man of very excellent administrative ability.

Edward J. Parkinson.

Mr. Parkinson, who was Chief Clerk in the Machinery Department of the Grand Trunk Railway, at Birmingham, Mich., died of erysipelas after a short illness on February 3 at that place. He was well known among railroad men in the western part of the country. He was born in November, 1844, near Belfast, Ireland, and came to this country when 16 years of age. He entered into the service of the Grand Trunk Railway as a boy in the Mechanical Department at Toronto, and remained in that employ until the time of his death. This was for a period of about 34 years. For the last 27 years he was Chief Clerk in the office over which Mr. Herbert Roberts, the Mechanical Superintendent, now presides. He was of a genial, kindly disposition, and was a good friend to a great many railroad men, who will be greatly grieved to learn of his death.

Loren Packard.*

After an illness of seven weeks Loren Packard, Master Car-Builder at the West Albany Shops, died on the afternoon of February 15 from liver trouble complicated with other diseases.

Mr. Packard was 52 years of age, and was born at Northumberland, N. H. He received his early education in the schools of Waterford and St. Johnsbury. While he was attending school the Civil War broke out, and he was one of the first to go to the front to defend the Union. He enlisted in the First Vermont Cavalry, serving four years. He was in the battle of Gettysburg, and was an eye-witness of the assassination of President Abraham Lincoln, in Ford's Theatre, in Washington, on the night of April 14, 1865.

After serving four years he went to Springfield, Mass., where he entered the Wasson Car Works, and learned the car-building trade. He soon became foreman of the shops, but resigned to accept the position of Master Car-Builder of the shops of the New York, New Haven & Hartford Railroad. He remained in these shops about five years. In 1881 he was offered the position of Master Car-Builder of the Mount Clair Shops of the Baltimore & Ohio Railroad, at Baltimore. He accepted the offer, and remained there about three years. On March 1, 1884, he was appointed to the responsible position of Master Car-Builder of the New York Central & Hudson River Railroad, in charge of the West Albany Shops to succeed the late Mr. Hoit.

* For some of the particulars relating to Mr. Packard's life, we are indebted to the *Albany Evening Journal.*

Mr. Packard was an excellent mechanic, and was truly a *master* car builder. He was a member of the Master Car-Builders' Association, and was for a number of years one of its executive members. He was possessed of an unusual amount of energy, and although his demeanor was ordinarily almost feminine in its gentleness, when emergencies required he manifested an amount of vigor and force of character which would overcome the greatest difficulties, and served to carry whatever he undertook to a successful issue.

He leaves a wife and one son 12 years of age. He was always active in church affairs, and was a member of the First Presbyterian Church of Albany, and for two years past acted as the Superintendent of its Sunday-school, and at the time of his death was President of the Young Men's Christian Association at West Albany. He will be sadly missed in all these relations, and excepting those who were endeared to him by family ties, his loss will be felt most by his old friends and associates. His frankness, generosity, and the kindliness of his character attracted to him many friends who will sincerely mourn their loss.

The funeral services were held on Monday afternoon, February 18, at the church of which he was a member.

Charles W. Copeland.

Charles W. Copeland, one of the best-known marine and mechanical engineers in this country, died in Brooklyn February 5 at his home on Columbia Heights, where he had lived since 1845. Mr. Copeland was born in Coventry, Conn., Conn., in 1815. His father, Daniel Copeland, was a builder of steam engines and boilers in Hartford, Conn., and established the beginning of the plant on the premises afterward occupied by the extensive concern of the Woodruff & Beach Iron Works of that city. Charles W. Copeland, under the direction of his father, was carefully trained in the profession of designing and drafting of steam vessels and machinery, and subsequently received practical instruction in pattern-making, founding, machine-fitting, boiler manufacture, and all the technique of the business then known, and later on became the Superintendent of his father's concern. In this place he designed and built a number of marine steamers for use on the Connecticut and on Southern rivers. About this time he placed himself under the guidance of Professor Hackley, of Columbia College, for instruction in the higher mathematics, of which later on he became an adept.

In 1836 he accepted the place of Designing and Constructing Engineer of the West Point Foundry, of New York, at that time the foremost plant of its kind in this country. While there he designed and built many marine engines, notably those for the United States naval steamer *Fulton*, the steam boats *Utica*, *Rochester*, *Swallow*, *Milwaukee*, *Cleveland*, and the ferryboats *Gold Hunter* and *Jamaica*, as also the *Bunker Hill* and *Lexington*, some of which were considered marvels of success in their day. He also built the first iron hull in the United States, a boat which plied on Lake Pontchartrain.

In 1839 he was appointed Constructing Engineer to the United States Navy—an office similar to that now occupied by the Chief of the Bureau of Steam Engineering. During the Mexican War he fitted out for the Government what was called the Mosquito fleet, consisting of such steamers as the *Spitfire*, *Scorpion*, *Scourge*, *Vixen*, etc. Later on he designed the engines and boilers of the United States naval steamers *Missouri* and *Mississippi*, and still later the engines and boilers for the naval steamer *Michigan*, for Lake Erie, which was the first iron steamer ever used for naval service. At a subsequent date he designed the machinery for the United States steamers *Saranac* and *Susquehanna*, in which he introduced many novel features of marine engineering. After this he became Superintending Engineer of the Allaire Works, of New York, where he designed and built the machinery for the Collins steamers *Pacific* and *Baltic ;* also the *Panama* for the California business ; the *Bay State* and *Empire State* and *Traveller* for the Long Island Sound, and the *Harriet Lane* for the United States Revenue Service. When the United States Steamboat Bill of 1852 was before Congress, Mr. Copeland was called upon for his opinion on many subjects, more or less new, then contemplated in the proposed law, and subsequently he was appointed the first supervising inspector under the new law for the New York district, which place he retained for about nine years.

During the War of the Rebellion Mr. Copeland was largely engaged in altering and fitting steamers for the fleets engaged on shallow waters of the Southern rivers, and it was through his advice that many double-enders were brought into use for the intricate channels of those rivers.

Since then he had been Consulting and Superintending Engineer to the United States Lighthouse Board, generally designing and superintending the building of vessels for that service. He was a director of as well as Consulting Engineer to the Norwich & New York Transportation Company, and while in that service designed the steamers *City of New York*, *City of Boston*, and latterly the *City of Worcester*.

All through his life he was a close student, and was a subscriber to most of the magazines and publications pertaining to his profession, both here and abroad, and was often himself a most interesting contributor, and in his earlier career delivered a course of lectures on the steam engine.

The deceased was a widower, and leaves one son, Charles E. Copeland, and four daughters.

We are indebted to the New York *Tribune* for most of the above account of Mr. Copeland's life.

PROCEEDINGS OF SOCIETIES.

The Engineers' Club of Philadelphia.—At a recent meeting Mr. V. Angerer read a paper on Investigation and Experiments for the Determination of the Groove in Guard Rails for Street Railways. The method of making the experiments was to take two pairs of wheels, carefully turned out of hard wood to accurate scale of 3 in. to 1 ft., and with their axles, on which they were turned, secured to a strong frame representing the truck, so that they could revolve freely, but without any play whatever. The frame was rigidly fastened in the centre to a stiff board extending at right angles with the truck to what would be the centre of the curve. A pin accurately turned and fitting snugly in holes in the board and holes in a wooden stand screwed to the floor formed the centre proper. A large piece of drawing paper was stretched on a board, and on it were laid rail blanks without any groove, formed out of potter's clay, following the curves described by the wheels when allowed to move, guided by the board from the centre of the curve to whatever radius it was set. The wheels were then set upon the rail blanks and weighted until their flanges sank into the clay to their full depth, at which point the whole apparatus was arranged to be exactly level. The wheels having previously been varnished. were thoroughly oiled, so that the clay would not stick to them. The first pair of wheels was then revolved from the axle by hand, and thus the truck moved along the potter's clay, the flanges cutting their own grooves into it. The length of arc available having been traversed, the truck was lifted away, and if a perfect impression had been obtained, short pieces were cut out of various parts of the arcs of both the inner and outer rail, and particularly of those parts which had been traversed by the front wheels only or the hind wheels only, and those that had been passed over by both wheels, as comparison of them would show whether or not the truck stood exactly square with the radial line, and on account of some peculiarities yet to be mentioned These pieces were cut out so that the cut would also sever the paper underneath, and extending a short distance inside and outside, forming a strip on and by which the cut-out pieces could be slid away upon another board and put away to dry and harden without handling the piece itself while yet soft, thereby avoiding possible distortion, except on the very ends by the cutting knife. As this latter was unavoidable, the pieces, after being thoroughly hardened, were sawed in half, so as to get at the central undistorted section, and the sawed surface ground smooth on a piece of slate, so as to present sharp lines. The shrinkage of the clay in drying could well be neglected, as actual measurement on a test piece showed that it would amount to a little more than $\frac{1}{64}$ in. in the full size width of the groove.

The wheel used had the Whitney standard flange for electric cars, and representative sections were obtained and enlarged to full size for the different sizes of wheels in common use, the four ordinary lengths of wheel base and radii of curvature for the rail differing by 5 ft. from 30 ft. to 65 ft.

The gauge of the track and the wheels was also considered, and it was found that for the usual gauges, flanges and wheel bases the track gauge is from $\frac{3}{8}$ in. to $\frac{1}{4}$ in. greater than the wheel gauge between the limits of 30 ft. and 60 ft. radii. A clearance of $\frac{1}{4}$ in. seems quite sufficient for street railways, and in fact will make cars run smoother on straight track on account of not allowing so much side sway. Diagrams of the results obtained were exhibited by the author.

The Southern & Southwestern Railway Club will hold its next meeting at the Kimball House, Atlanta, Ga., on Thursday, April 18, 1895, at ten o'clock A.M. The subjects for discussion will be: 1. Revision of Master Car-Builders' Rules of Interchange ; and any member having any suggestions to make or changes to recommend will please transmit the same to Mr. R. D. Wade, S.M.P., Southern Railway Com-

pany, Washington, D. C., Chairman of Committee on M. C. B. rules. 2. What is the Cause of Uneven Wear of Driving-wheel Tires Running in the Southwestern Territory? 3. What is the most Economical Method of Obtaining Compressed Air for General Use in Railroad Shops, and its Application? 4. Discussion of the Report on Counter-balancing of Driving-wheels. 5. Additional Report of Committee on Draft Sheets, and Discussion of the Subject. 6. What is the most Economical Tonnage Spring: the Elliptic, Half Elliptic, or the Coil, Considering the First Cost and the Duration of Efficiency of Each, and its Effect on the Rolling Stock and Track?

American Society of Mechanical Engineers.—Arrangements have been made for holding the monthly meetings of mechanical engineers that were so successfully inaugurated during the last season. They will be for the discussion of mechanical subjects, and will be held at the rooms of the Society, at 12 West Thirty-first Street, New York City. The proceeding of each month will consist of an address on some topic of current engineering interest, delivered by an engineer at the invitation of the committee, followed by a discussion of the subject by those in attendance. Persons interested in the subject of discussion are invited to send objects, such as test specimens, photographs, drawings, etc., which may be of interest in connection with the topics to be considered. Members who are unable to attend the meetings are invited to send written discussions on the subject for the evening. The first meeting was held on Wednesday evening, January 23, when Mr. A. Fteley, Chief Engineer of the Aqueduct Commission, presented a paper on the Growth of the Water Supply of New York from Early Days to the Present Time. The meeting was presided over by Mr. Charles H. Loring, Chief Engineer of the United States Navy. The second meeting was held on the evening of Wednesday, February 13, when the subject of the application of electric motors to the driving of machinery was presented and discussed. A report of the meeting will be found in another column of this issue. The dates for future meetings will be Wednesday, March 13, Wednesday, April 10, and Wednesday, May 8.

American Railway Master Mechanics' Association.—The following circular has been issued by the committee on the Utilization of Railroad Scrap Material: "Your committee to report on Utilization of Railroad Scrap Material and the Best Method of Handling the Same, desires information upon the subject from every member of the Association. This may take the form of a general statement covering the treatment of the scrap pile as a whole, or a detailed account of your method of utilizing some part of the material usually found therein, or preferably both. Figures showing the saving in cost, or the reverse, resulting from the working over of scrap, as compared with the cost of new material with the scrap, value of the old material deducted, will be especially desirable. The following questions are given merely by way of suggestion, and it is not expected or desired that members will confine their replies to answers thereto: 1. What is your method of sorting scrap material? 2. Do you arrange with reference to possible future use, or only with reference to kind of material? 3. What classes of scrap can be conveniently used without passing through the foundry, the rolling mill or the forge? 4. What are some of the instances in which the working over of scrap may be expected to show an economy over the cost of new material, and can you give in detail methods found best in your own experience? 5. Can you suggest any way in which economical use may be made of scrap bolts, nuts, links and pins, springs, truss rods, tires and other of the smaller parts of rolling stock which accumulate most rapidly in the scrap pile? 6. What use do you make of scrap axles? Though this subject has been but little discussed, it is one which has an important bearing upon railroad economy, and is therefore one in which every member has an interest. This, added to the practical knowledge which each member must have with some phase of the subject, should insure such a number of full replies as to enable your committee to submit a complete report. Answers should be mailed to H. P. Robinson, Monadnock Block, Chicago, Ill., at the earliest possible date.

Master Car-Builders' Association.—The following circular has been issued by the committee having in charge the revision of the rule of interchange:

"In presenting this circular your committee trusts that it will not be considered as undertaking the question in hand in any radical way. There has been a tendency for the past few years in the deliberations at the Master Car-Builders' conventions, and in the actions of these conventions, to put upon car owners, in the rules of interchange, more and more responsibility for defects in freight cars, and it is now the intention of the committee to see whether the matter cannot be put in such shape as will decrease not only the cost of repairs to the railroads of the country, but will also eliminate the serious detentions to cars which occur at all interchange points.

"The idea is to have cars pass from one road to another if in safe condition for movement, and that the inspection, in so far as stopping cars at junction points is concerned, shall be made simply for safety.

"It should be considered that the railroads, when moving foreign cars, are paying to their owners for their use a sum, in a general way, adequate to cover all natural wear and tear and replacement of equipment destroyed and worn out; so that, in a general way, the owners of cars are paid for the cost of repairs necessary by foreign mileage of their cars.

"It is probably time that the selfish view, as acted upon at interchange points, in endeavoring to make the connecting lines stand all expense possible in repairs of cars which may be offered for movement, should be considered as no longer serving the individual interest of railroad companies.

"It is desired to have a full expression of your opinion, especially in connection with the questions following, sending same to the Chairman, Pulaski Leeds, care of Louisville & Nashville Railroad Company, Louisville, Ky.; and we trust that you will look upon the matter in as broad a view as possible, considering always that the general interest of the railroads at large must be the interest of individual railroads in nearly all cases: 1. How many men do you employ as car inspectors whose services could probably be dispensed with if the inspection were made for safety only, instead of being made for protection also, as is now necessary under the rules of interchange? 2. Are you in favor of owners being held responsible for the condition of cars except in case of accident or casualty, no repairs to be made except by owners, unless the car is in unsafe condition to run? 3. If so, have you any suggestions to offer as to what shall be considered *prima facie* evidence of unfair usage? 4. If this rule were adopted, would you restrict its application to roads owning a certain number of cars per hundred miles operated? If so, what would be your recommendations? 5. If not in favor of an absolute responsibility of owners, are you in favor of increasing the number of parts included in rule No. 8? If so, please enumerate parts; and, if necessary, conditions. 6. If you would recommend a greater number of parts for which owners are responsible, than those for which they are not, would you recommend changing the rule to read: 'Owners will be responsible for all defects developing under fair usage, except' (giving exceptions you would recommend)? 7. If, in your opinion, these questions do not cover the ground fully, will you please aid the committee by giving your ideas on the subject, regardless of or in addition to the questions?"

COAL CAR SIDES.

"Your committee requests a blue print of your latest design of coal car body, showing in detail the method of bracing the sides, and replies to the following questions: 1. How many cars with sides of this design have you? 2. When were the first of your cars with sides of this design placed in service? 3. What weaknesses, if any, have these sides developed in service? 4. At the present time, do you know of any other design of sides that you consider superior to this one? If so, please send print of it, if possible. Any further information that you may be able to give on the subject will be appreciated by the committee. If you have no cars of this class and no information to offer, please reply to that effect. Please address your reply and send blue print to the Chairman, R. E. Marshall, Broad Street Station, Philadelphia, Pa."

ACTION OF THE AMERICAN RAILWAY ASSOCIATION ON M. C. B. STANDARDS.

The Secretary is advised by letter from Mr. W. F. Allen, Secretary of the American Railway Association, under date of January 17, 1895, as follows:

"At a meeting of the American Railway Association, held on October 17, 1894, the following resolution was adopted:

"*Resolved*, That the Details of Car Construction, adopted by the Master Car Builders' Association, as published with the proceedings of its convention, held at Saratoga in June, 1894, be and are hereby adopted as standard by the American Railway Association, and all railway companies and car builders are recommended to conform thereto as soon as practicable.

"In accordance with the instruction of the Association last June, the Executive Committee took up the question of standards with the American Railway Association, and the result has been as above.

"Members are urged to consider the importance of following this matter up and taking up the standards of the Association with the proper officers of their respective companies, and advocate their general adoption."

MECHANISM FOR BORING LOCOMOTIVE CYLINDERS.

Mr. James Buchanan, Assistant Superintendent of Machinery on the New York Central & Hudson River Railroad, at West Albany, N. Y., has designed and patented an appliance for reboring locomotive and other engine cylinders, and refacing valve seats by power supplied by compressed air or steam obtained either from the locomotive itself or from any other available source. The boring and refacing apparatus which is used is the same as that which is commonly operated by hand. This process was, however, tiresome and tedious, and consumed a great deal of time, during which the locomotive was kept out of service. Mr. Buchanan designed a little oscillating engine with a cylinder 4 in. in diameter, which may be adjustably attached to the cylinders of locomotives, and is adapted for boring those of any size. Fig. 1 represents a side view of the front part of a locomotive, with the apparatus attached ; 2 is the locomotive cylinder and 10^a that of the motor, which is connected to a shaft, 22, which carries two pulleys, only one of which, 23, is shown in fig. 1, the other being on the opposite end of the shaft 22 ; 23 is belted to another pulley, 47, which drives the cylinder-boring mechanism, and the pulley on the other end of the shaft 22 is belted to a pulley, 101, which drives the valve seat facing apparatus. Those who are familiar with the machines which are used for reboring cylinders and refacing their valve seats will readily understand the operation of Mr. Buchanan's device. Steam or compressed air is conducted either from the boiler or air pumps of the locomotive, whose cylinders are being rebored, or from any other source, through the pipe 25^a, hose 25^b, 26^a, and pipe 25 to the motor cylinder 10^a. The supply of steam or air is regulated by a cock, 26.

This appliance has been used for a considerable time in the shops of the New York Central Road, where, as in some other shops, compressed air is employed more and more for handling various kinds of work.

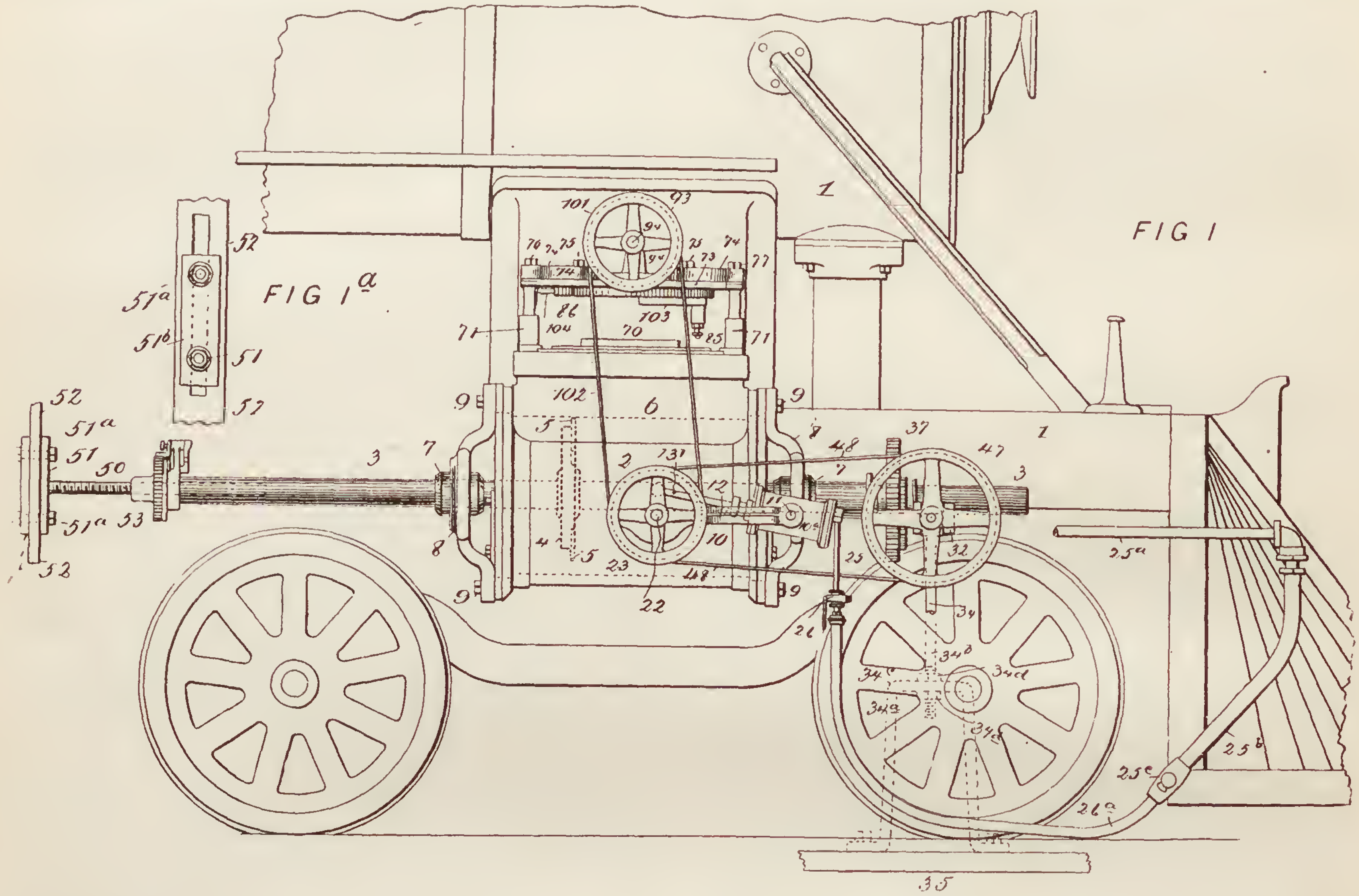
Fig. 2 is an enlarged side view of a locomotive cylinder, 2, and of the motor engine, but with the position of the latter reversed from that in which it is shown in fig. 1. Fig. 3 is a side view and fig. 4 a section of the motor cylinder 10^a. Fig. 5 is a plan view showing the refacing apparatus, the motor engine, and part of the reboring mechanism, with the motor cylinder in the same position as it is shown in fig. 2. Fig. 6 is a still more enlarged side view of the motor engine, looking at the back of it or in the reversed direction from that in which it is shown in fig. 2, and fig. 7 is another side view of the motor, in which it is represented as in fig. 2, but on a larger scale. Fig. 8 is an end view of the motor cylinder and its attachments.

In the illustration the heads of the locomotive cylinder are removed and a boring shaft or spindle, 3, is shown passing centrally through the cylinder. In figs. 1 and 3 a tool carrier, 4, having suitable tools 5 5 for boring the inside surface of the cylinder, is shown on the shaft. Two tools are shown on the carrier in the figures last referred to ; but three may be used arranged as shown in the end view of them shown in fig. 9. The shaft 3 is journalled in bearings 7 (figs. 1, 3 and 5) carried by suitable brackets or yokes, 8, which are fastened to the ends of the locomotive cylinder 2 by bolts, 9.

In boring the cylinder the shaft 3 is rotated by the motor engine 10, which might be of any other design, but Mr. Buchanan has adopted the oscillating type as the simplest form of engine. The motor cylinder is supported by a suitable frame, 12 (figs. 1, 2 and 5), which is attached to the locomotive cylinder by brackets 14 and 20. These are made adjustable so that the motor may be applied to cylinders of different dimension. An end view of the bracket 14 is shown in fig. 8, from which it will be seen that it has a curved slot, 15, adapted to receive the bolts or screws 16 by which the cylinder head is fastened on the cylinder. The slot permits the bracket to be adjusted in any desired position. By means of the brackets 18 and 20 (figs. 2 and 5) the motor frame is attached to the other end of the locomotive cylinder, as shown in the engravings. The two brackets are fastened together by a bolt, 19^a, which passes through a slotted hole, 19, in each bracket, which permits the brackets to be adjusted to different lengths of cylinders.

The trunnion 11^a (figs. 5 and 6) is journalled in the plate 13, and is provided with a tension spring, 17, to hold the ports of the cylinder against the plate 13 in a well-known manner. The plate 13 (fig. 6) has exhaust holes, 13^a, 13^b, which are adapted to align alternately with ports 13^c, 13^d, in the cylinder 10^a as it oscillates. The ports 13^c and 13^d in the cylinder are also adapted to alternately align with ports 26 and 27 in a bar, 28, having a steam or air channel, 29, the channel 29 communicating with the pipe 25. The bar 28 is secured to the plate 13 and is bent at 30 to permit the passage of the trunnion or pivot 11^a.

With this arrangement, as the cylinder 10^a oscillates its ports 13^c, 13^d, will alternately align with ports 26 and 27 to receive steam and with holes 13 and 13^a to permit the exhaust to take place ; 31 is the piston-rod of the cylinder 10^a, which is



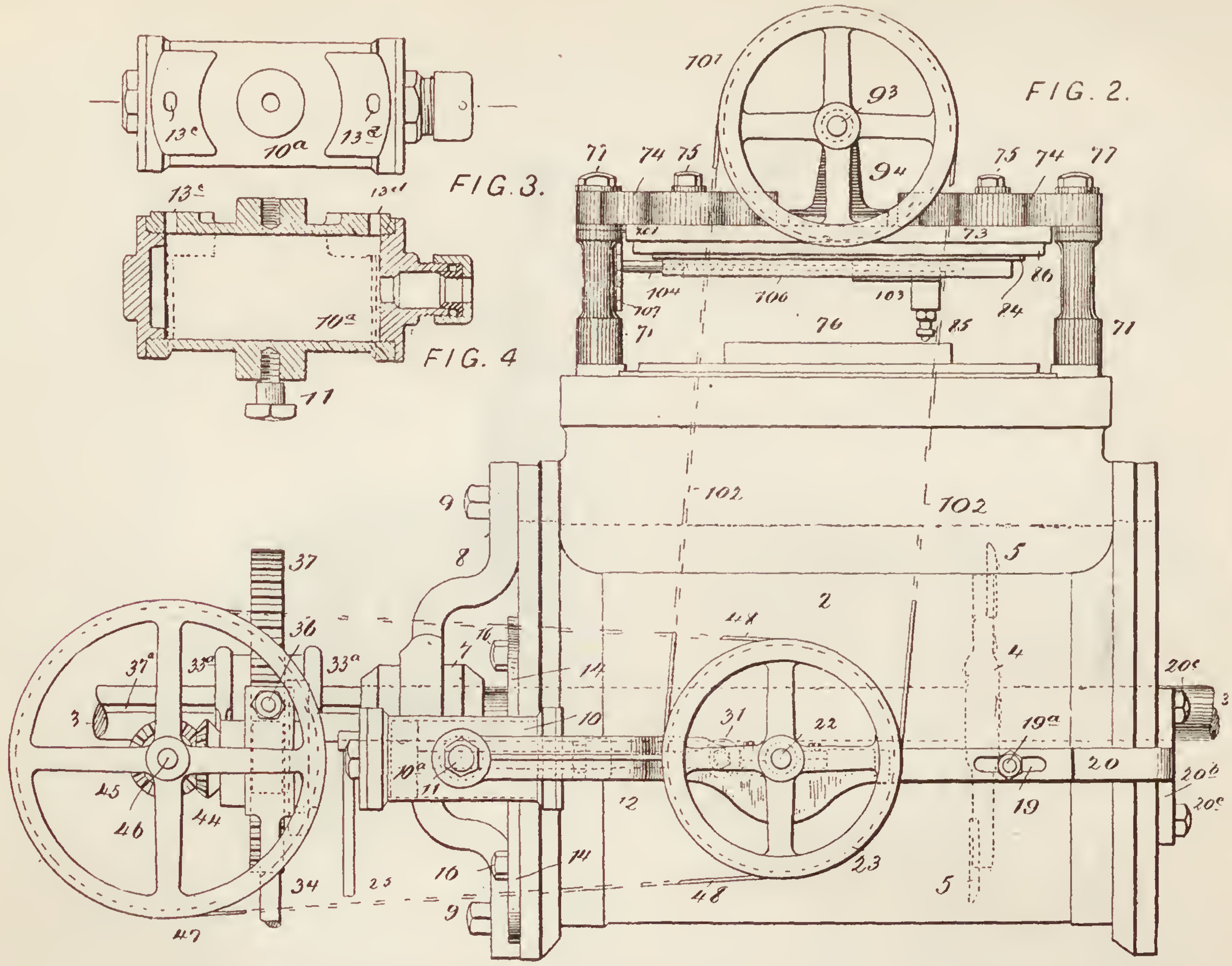


FIG. 3.

FIG. 4

FIG. 2.

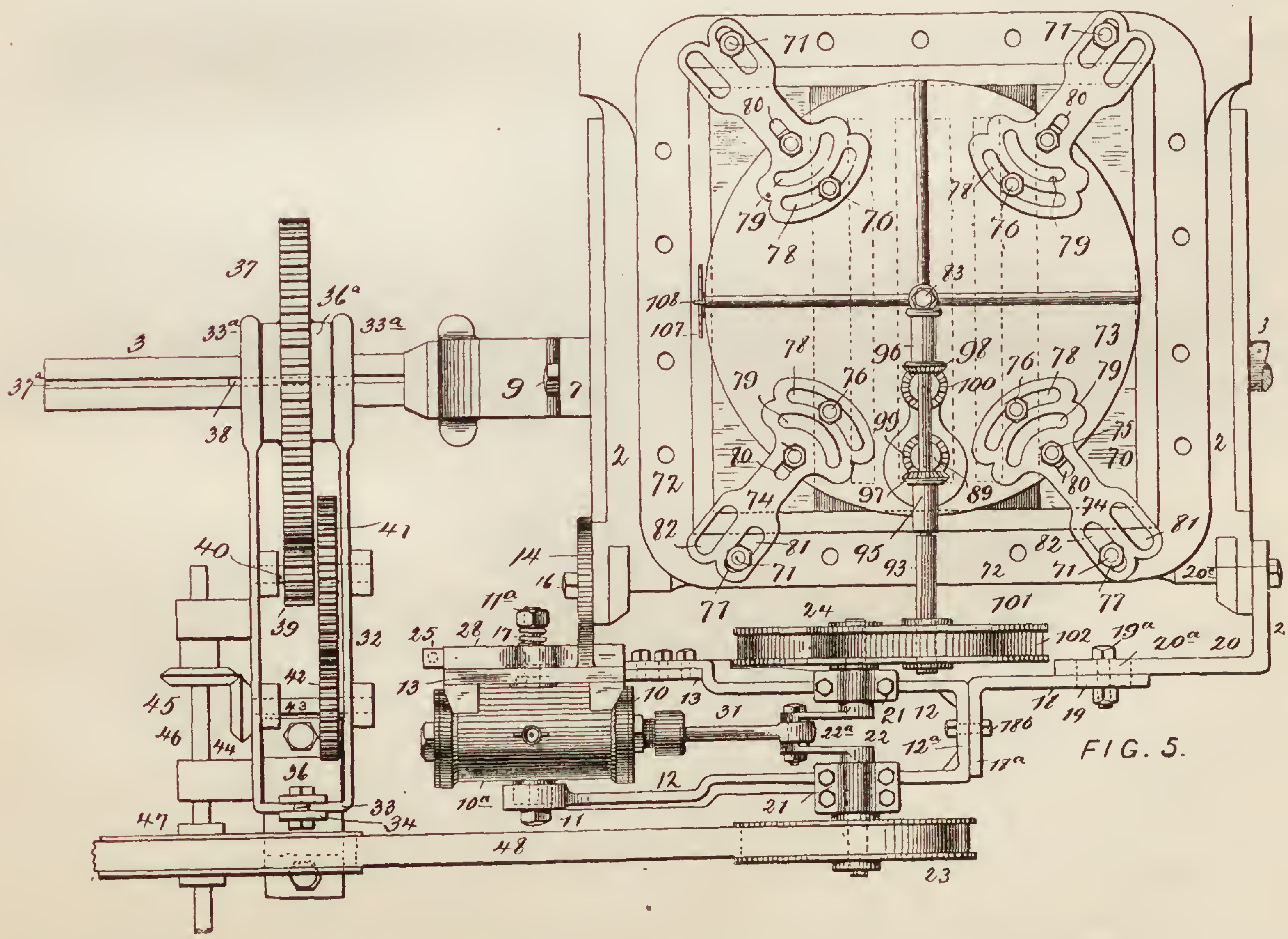
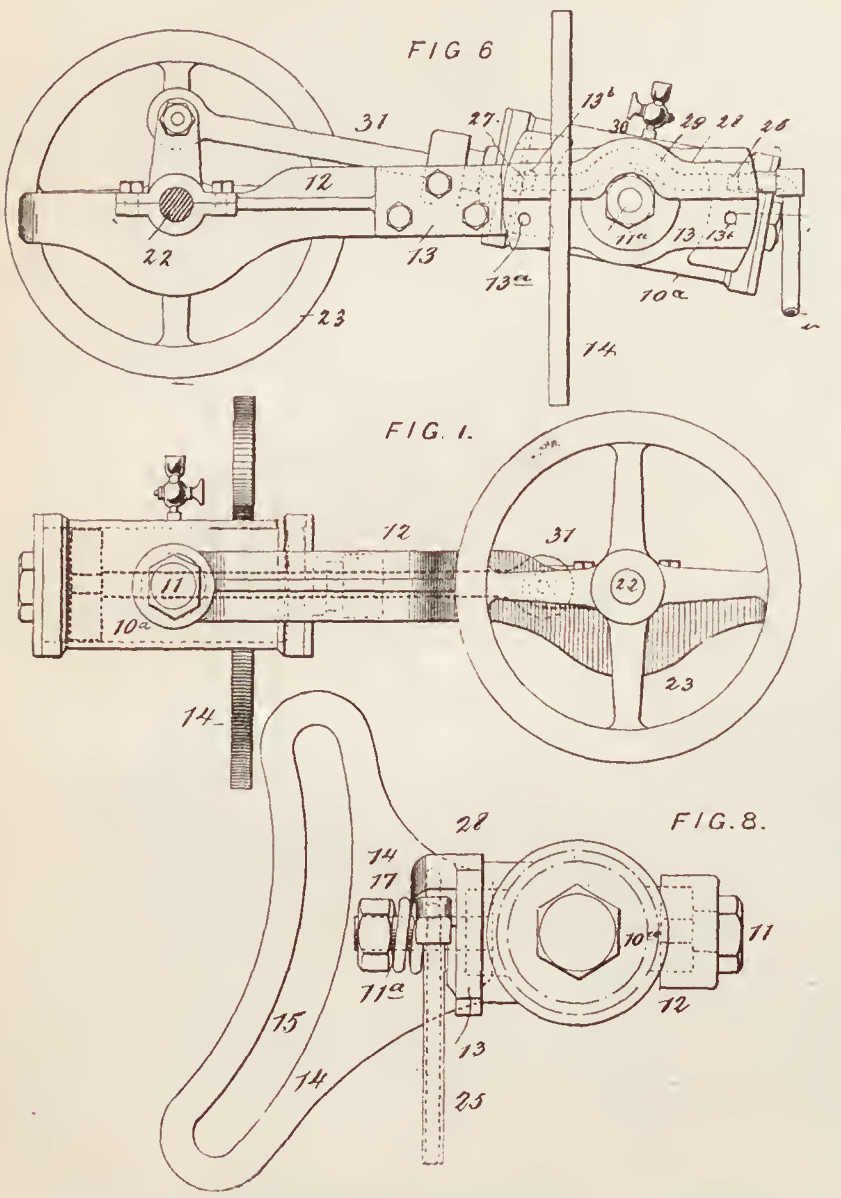


FIG. 5.

MECHANISM FOR BORING LOCOMOTIVE CYLINDERS.

connected with the crank on shaft 22; but it will be understood that any other desired arrangement of engine or means for operating the driving shaft 22 may be used.



MECHANISM FOR BORING LOCOMOTIVE CYLINDERS.

The machines used for boring the cylinders and for facing the valve seats are so generally used and are so well known that no description is required. The machine for facing the

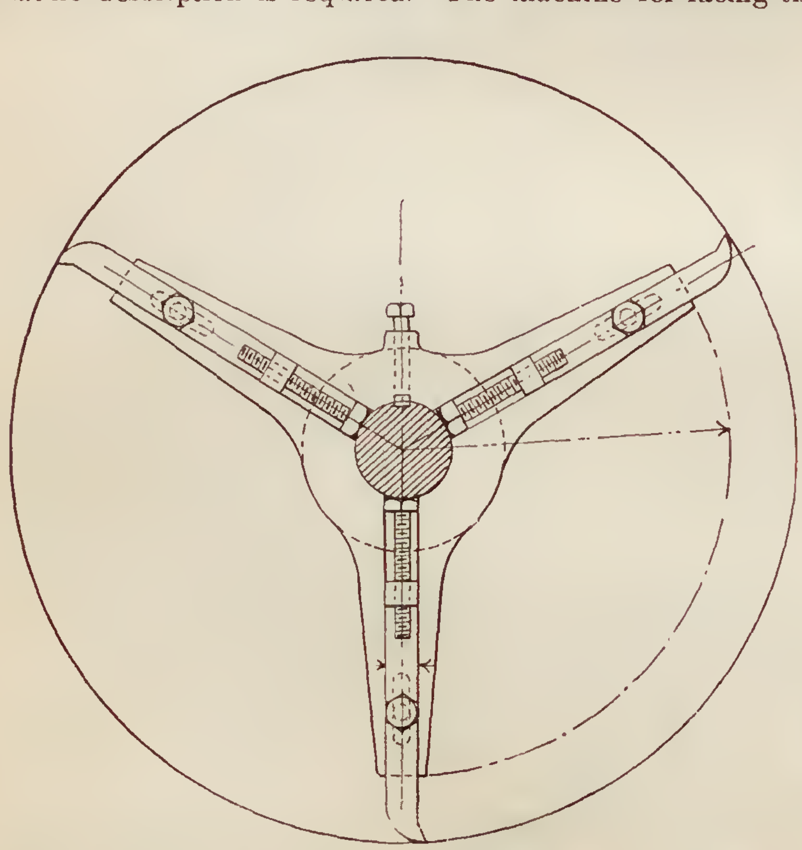


Fig. 9.—MECHANISM FOR BORING LOCOMOTIVE CYLINDERS.

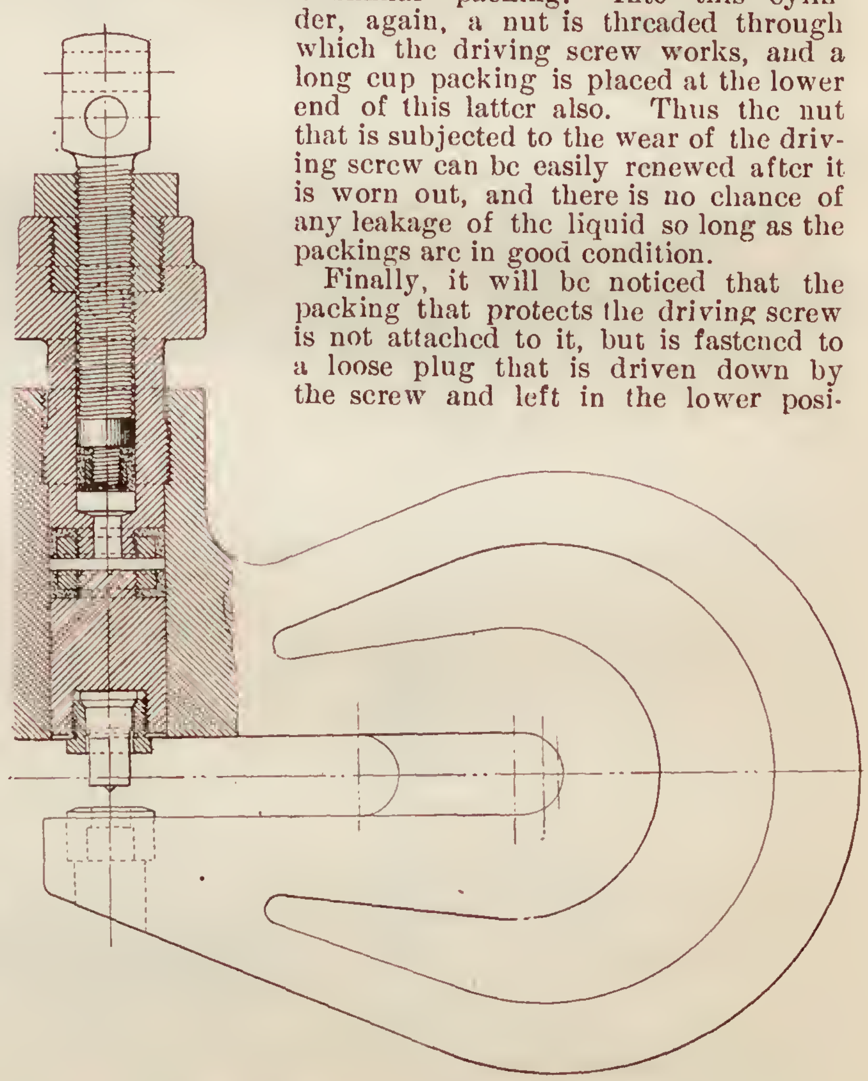
valve seats is of the rotary type, and is now found in nearly all American locomotive repair shops. Mr. Buchanan's patent is dated January 1, 1895, and is numbered 531,773.

COMBINED SCREW AND HYDRAULIC PUNCH.

In our issue for November we illustrated two forms of a combination of screw and hydraulic power. One was for a press that is in use in a railroad shop for pressing out the bolts of pedestals and other work of a like nature, and the other, a punch that worked all right when it was new, but which, after the parts had become worn, was apt to leak on account of the lack of packing about the screw. The illustrations shown here represent a combined screw and hydraulic punch that is made by Watson & Stillman, of New York. The appearance of the tool is well shown by the perspective engraving, while the construction will be readily understood from the sectional engraving. From an examination of this latter it will be seen that no dependence at all is placed on the holding power of the screws to retain the liquid. The punch itself is, of course, furnished with a packing which is of leather in cup form, and then the cylinder in which the screw moves up and down, and which is screwed into the body of the punch, is made tight by a similar packing. Into this cylinder, again, a nut is threaded through which the driving screw works, and a long cup packing is placed at the lower end of this latter also. Thus the nut that is subjected to the wear of the driving screw can be easily renewed after it is worn out, and there is no chance of any leakage of the liquid so long as the packings are in good condition.

COMBINED SCREW AND HYDRAULIC PUNCH.

Finally, it will be noticed that the packing that protects the driving screw is not attached to it, but is fastened to a loose plug that is driven down by the screw and left in the lower position when the screw is withdrawn, being forced back to its upper position when the punch is raised after the work is done.



SECTION OF COMBINED SCREW AND HYDRAULIC PUNCH.

AERONAUTICS.

UNDER this heading we shall hereafter publish all matter relating to the interesting subject of Aerial Navigation, a branch of engineering which is rapidly increasing in general interest. Mr. O. Chanute, C.E., of Chicago, has consented to act as Associate Editor for this department, and will be a frequent contributor to it.

Readers of this department are requested to send the names and addresses of persons interested in the subject of Aeronautics to the publisher of THE AMERICAN ENGINEER.

AUTOMATIC LONGITUDINAL STABILITY.

WHOEVER has experimented with flying models in the open air knows that the principal difficulty to overcome is that of preserving the longitudinal equilibrium under varying conditions of speed and wind. The bird does this by instinct, through reflex action of the nerves and muscles, aided perhaps by an automatic arrangement not yet understood; but man will need, to secure his safety, a "mechanical brain," which will instantly perceive any change of conditions in the air and apply the proper remedy to preserve the stability.

A good many experiments have been made to effect this with the hanging pendulum; but not only is this slow and weak in action, but it imparts an oscillating motion to the apparatus which is exceedingly objectionable.

In 1891 Mr. Thomas Moy proposed to remedy this difficulty by employing an *inverted* pendulum with a very small range of motion, which should bring into action an *independent force*, to adjust a flying apparatus instantly to the changing conditions. For this he took out British patent No. 14,742 of 1891.

Mr. Moy is a veteran aviator. He tested in 1875 "Moy's aerial steamer," which weighed 216 lbs. and was provided with a steam engine of 3 H.P. This was unable to gain sufficient speed to raise itself from the ground; but this experiment, as well as a subsequent one in 1879 with "Moy's military kite flying machine," satisfied him that the securing of automatic stability was one of the first requisites for success, and after these many years of consideration he brings out the present proposal.

From a paper read by Mr. Moy before the Aeronautical Society of Great Britain, December 15, 1894, we extract the following description of the device:

"Two methods of carrying out my invention are shown in my specifications, and I now propose to describe and explain the simplest of the two methods. . . .

"Referring to fig. 1: Piece 3 is a transverse horizontal shaft projecting outward on each side of the stern portion of the vessel, to port or starboard, the outer ends being fitted with horizontal planes used for steering; 4 is the tiller, the outer end passing through the vertical guide 5 and entering the slot 6 in the rack 7, as also shown in fig. 2. In the position here shown the tiller and the steering planes or rudders are supposed to be in a perfectly horizontal position.

"Piece 8 is a shaft formed in two parts, joined at 9, and fitted with a pinion at 10. This pinion is bored out to receive a ball fitted to the end of the arm 13. The shaft 8 is kept constantly rotating by some source of power, such as clockwork, or by connection with the machinery carried on board or by a treadle worked by the foot of the aviator, very little power being required to rotate the shaft.

"The rack 7 is capable of sliding horizontally in guides, the arms 20 being extended for that purpose; and the pinion 10 and tiller 4 are guided vertically in the guide 5.

"The inverted pendulum 11 is pivoted at 12. The arms 13 and 14 balance each other, each having a ball at its outer end. The bars 15 and 15 limit the play of the pendulum to, say, ½ in. in each direction; but even this limited play of the pendulum may be further reduced by means of electric contact appliances. Piece 16 is a screw-threaded rod fixed to the bars 15 and 15, and passing through a slot in the pendulum rod. Pieces 17 and 17 are two nuts for regulating two light springs, 18 and 18, which keep the pendulum in a vertical position only when the vessel is truly horizontal, but immediately give way when the vessel departs from this course.

"The mode of operation is as follows: Supposing that the vessel is travelling from left to right on an even keel, and that the shaft 8 is turning in the direction of the bent arrow; then the pinion 10 rotates freely between the teeth of the rack 7 and the rack remains stationary. Now, suppose that the head of the vessel rises two or three degrees, then the pendulum immediately falls against the after bar 15, raises the pinion 10, and thereby drives the rack 7 from left to right. This operation lowers the tiller 4, and with it the steering planes on shaft 3. The effect of this will be to slightly raise the stern and to restore the vessel to the horizontal position.

"In order to slow up the vessel gradually and to come gently down to earth, one has only to push the pendulum forward by hand, when the rack 7 will be driven from right to left by the pinion 10; the tiller and steering planes will then be inclined upward, thus bringing the stern downward. The increased angle of inclination at once reduces the speed of the vessel, and it approaches the ground slowly so as to land safely.

FIG. 1

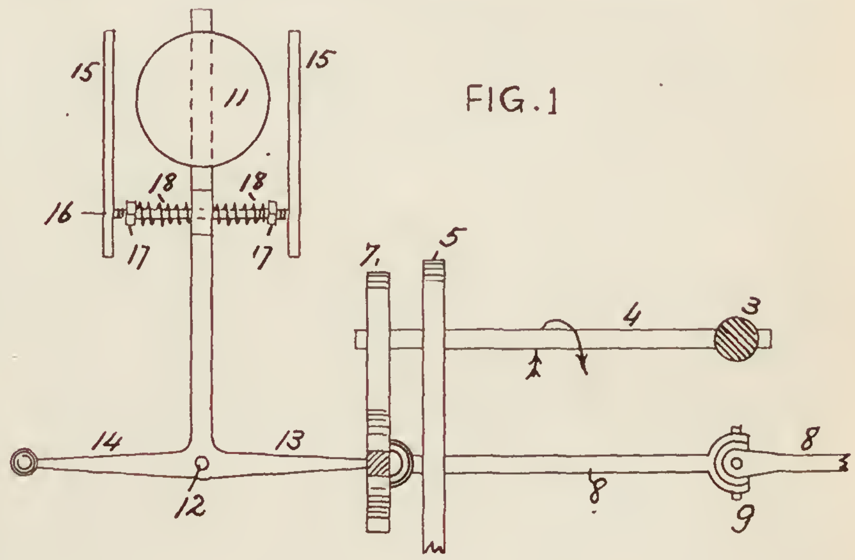
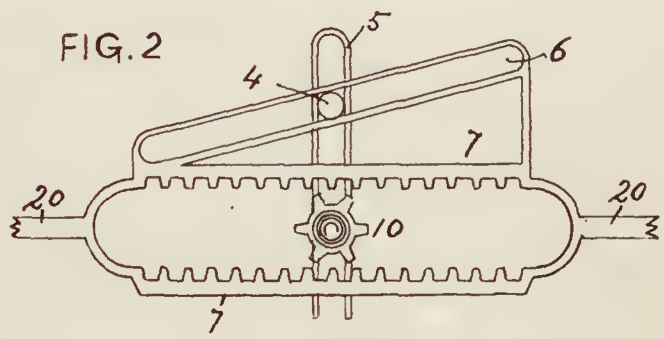


FIG. 2



"In case of an accidental stoppage of the rotating shaft 8, the pendulum may be fixed and the rack 7 operated by hand through a lever attached to one of the guide bars 20, or the shaft 8 may be turned by manual power.

"It is evident that the mechanical details may be varied to a very great extent."

Mr. Moy estimates that for a one-man soaring apparatus the whole of the automatic stability device would not exceed 6 lbs. in weight. There are a good many working parts, but they are all light, and the design is not as complicated as may upon first sight appear. The proposal to apply an inverted instead of a hanging pendulum seems to possess merit; and it is to be hoped that some practical experiment upon an adequate scale will be made to test the value of the device in conferring automatic equilibrium upon a flying apparatus.

THE HIGH ASCENSION OF THE "PHŒNIX" ON DECEMBER 4, 1894.

DR. A. BERSON has published in the *Zeitschrift für Luftschiffahrt und Physik der Atmosphäre*, an authentic description of his latest and exceedingly high balloon ascension made with the *Phœnix* on the 4th of last December.

The prevalence of a strong east wind during the afternoon placed the possibility of making a lofty ascension somewhat in doubt, and it continued through the night; yet in order that the start might be made, Lieutenants Gross and Marker, at five o'clock in the morning, suddenly ordered that the *Phœnix* be inflated with 70,600 cub. ft. of water gas. According to the special purposes of this ascension, it had been Herr Berson's intention to take no others with him. Therefore the heavy 80-lb. anchor was left behind. The drag line, having a length of 650 ft., and weighing by itself 180 lbs., was stretched out over the ground in the direction of the wind, in order that

it might not exert too much of a strain and tend to hold the balloon down at the start. The instruments and attachments were adjusted in the most convenient way possible in order that the observations could be made and registered with the least possible danger of exhaustion at the high altitudes. At 10.28 the command to "Let go!" was given. In 15 minutes the balloon had risen to a height of 6,500 ft. As the direction taken was northwesterly, the whole Hartz range lay on the horizon at the feet of the aeronaut. It was generally foggy, and thick masses of cloud lay over the earth here and there. The temperature at first increased up to a considerable height; at 4,900 ft. the thermometer indicated 5° C. (41° F.). Herr Berson alternately made a double series of readings of his instruments in order that they might be as accurate as possible, cast a glance at his balloon, the lines and the earth, and threw overboard a couple of sacks of ballast. An hour after starting an altitude of 16,400 ft. had been reached; the temperature had dropped to zero of the Fahrenheit scale, and the air was very dry. The rays of the sun were weak.

At the height of 13,800 ft. the first weakness of the action of the heart was experienced, after throwing over a heavy sack of ballast, and the pile of sandbags that had been heaped up in the car was now entirely exhausted. At 11.49 Herr Berson had reached the height of 19,700 ft., and the thermometer had dropped to 14° F. below zero; but on his memorandum he has written: "Slight palpitation of the heart; slight confusion; in other respects, well." At twelve o'clock, or an hour and a half after starting, and at a height of 22,150 ft., and with the thermometer 20° below the Fahrenheit zero, he began the artificial inhalation of oxygen, and with excellent results. Sack after sack was thrown overboard, and at 12.25 the bold aeronaut had reached the height of 26,250 ft., the temperature being 38° below the Fahrenheit zero, and he had thus broken his own record for high ascensions, which had been put at 26,000 ft. on May 11. At the same time the health was better than before, and yet he was only taking about one respiration per second of the oxygen; he was without dizziness, and was in possession of the possibility of continuing his work. So, by constantly resorting to the artificial breathing, Herr Berson was able to attend to his affairs. His eyes alone gave him some trouble; he aroused himself from his sleepiness by a sudden loud shout; and particularly dull and flat did his voice sound in that thin air. At 25,260 ft. he reached the altitude at which Glaisher had taken his last temperature reading, and which is given in his "Voyages Aeriens." At 26,900 ft. Berson recollected that it was at this height that the two Frenchmen had lost their lives; at 27,900 ft. he had attained the greatest altitude that had heretofore been attained, which was by Glaisher on September 5, 1892, when he drained his barometer. About here he fell into a swoon, from which he first awoke after his attendant had checked the balloon from rising higher. After a momentary observation of himself he looked to the condition of the ballast, and then Herr Berson made preparations to rise still higher. The temperature had now fallen to 43° F. below zero. At about 29,500 ft. the balloon finally cut through what he had already observed higher in the heaven, a thin, veil-like strata of cirrus clouds. They did not consist of ice crystals, but of small, perfectly formed flakes of snow. At 12.45, or about 2¼ hours after starting, the barometer stood at a height of only 9½ in., which indicates a height of 31,500 ft., and corresponds to an actual height, in round numbers, of about 30,000 ft. The thermometer had dropped to −54° F.; the quicksilver in the barometer had frozen at −20° F., and the radiation thermometer indicated only −11° F. under the direct rays of the sun.

The balloon was now stationary. There were only one small and six large sacks of ballast remaining, and these were necessary for insuring safety in the descent and landing. The balloon was covered with a thin envelope of snow, pure from the clouds, while above it there was nothing but the cold blue vault of the heavens. The judgment of the investigator told him that it would be safe, by the exercise of proper precautions, to rise 3,000 ft. higher. But he dared not undertake it without the help of an assistant aeronaut to handle the balloon, and so the ascent on this trip was brought to a close. At the greatest height of 30,000 ft. he felt very well, as already stated. When the *Phœnix* had once again reached the height of 29,850 ft., the thermometer being at −52° F., Herr Berson pulled down the small gas valve. The balloon at once began to fall, but stopped again at 24,600 ft., where the valve was reopened. And many another tug at the valve had to be made. While they were still at a height of 27,900 ft., a very crooked river was crossed; it was the Elbe, and near it the landing was afterward effected at Domitz.

The terrible cold now began to have its effect upon his movements, and Herr Berson shivered in his fur coat, and was obliged to crouch down in the car at every instant. The balloon settled down slowly and gently, and only one sack of ballast was thrown out to soften its descent, while at a height of 11,500 ft. Then the rapid reascent of the *Phœnix* was checked by a pull at the valve cord. The earth was now so thoroughly wrapped in clouds that he lost his bearings. As the descent was of some duration, it became possible to make another series of observations. The highest temperature was found at 4,600 ft., where the thermometer registered +43° F. Between this point and the earth it dropped to about +34° F. Herr Berson was for a full hour after the culmination at a height of 17,000 ft., two fingers were frozen, and circulation was only restored in them after an energetic rubbing. The barograph was also injured and stopped by the intense cold.

At three o'clock, as the heavens appeared threatening in the north, the investigator decided to bring the balloon down as rapidly as possible. While he was "swimming" on the upper surface of some cloud waves, at a height of about 1,650 ft., a large city and a steam whistle made itself evident below. At 820 ft. the gray earth appeared through the clouds; the balloon flew over a lake in a gust of wind and landed, by the aid of the inhabitants thereabouts, at 3.45 P.M., in a favorable spot on a ploughed field a short distance west of Kiel on the same evening upon which the patron of the *Phœnix*, the Emperor, stopped at Kiel.

The ascent had occupied 3 hours, and the descent 2 hours and 20 minutes. The important results obtained may be briefly stated to be: (1) the attainment of a greater altitude than any that has heretofore been reached; (2) the observation of an uncommonly low temperature at these heights, and very many wider variations of temperature between the altitudes of 4,900 ft. and 30,200 ft. than we have yet observed in the winter; (3) early and evening-like return of temperature at about 4,900 ft.; (4) the comparatively very slight insulation, even at the greatest height, in contrast with the observations made in May; (5) the perfect interdependence of the proportion of moisture and the fine haze in the heavens in the highest strata of clouds, even at the enormous height of over 32,800 ft; (6) snowflake structure of the cirrus clouds at a height of 29,500 ft.; (7) great increase in the velocity of the wind currents above; which, while it is almost calm on the surface of the earth, sufficed to carry the balloon 186 miles in 5 hours and 17 minutes, corresponding to a velocity of about 54 ft. per second for the average of the whole time.

A PLAN FOR AN AERONAUTICAL CAMP-MEETING.

Mr. James Means, of Boston, who is greatly interested on the subject of Aeronautics, has issued in the form of a circular, which is reprinted herewith, a proposal to hold an aeronautical camp-meeting some time next summer. We heartily endorse the scheme, and trust it will be carried out. The following is the circular referred to:

"The suggestion, for a definite plan of action which I offered in the *Aeronautical Annual** have opened an interesting and encouraging correspondence with the students of man flight in various parts of the country which leads me to give further details of the plan.

"These are hereby submitted in a somewhat crude form with the expectation that experimenters will be free in their suggestions for improvements of them.

"There are scores, if not hundreds, of experimenters who, widely scattered, are missing the opportunity of seeing each other's experiments.

"It is probable that a considerable waste of energy occurs in the duplication of experiments.

"If, during the summer or autumn of every year, the experimenters were to assemble for a fortnight at an aeronautical camp-meeting, where all the facilities for their work were provided, much more rapid progress could be made than has been made in the past.

PLACE OF MEETING.

"As for the place of meeting, the necessary seclusion could be found somewhere on Cape Cod; the scarcity of trees there, and the comparative steadiness of the wind also recommend it.

CLASSES OF EXPERIMENTS.

"There should be several classes of experiments, each under the direction of a specialist. For examples:

"*Class I.* Soaring machines launched from captive balloons. (See the *Aeronautical Annual*, 1895, pp. 151 to 168 inclusive.)

* A notice of this will be found on another page.

Two captive balloons could be provided, one of about 10,000 cub. ft , to carry an aeronaut and car ; this balloon to be used only in the most favorable weather ; another balloon of about 1,200 cub. ft., which, having no aeronaut, could be risked in any weather.

"*Class II.* Kites. Mr. Chanute's 'Progress in Flying Machines' * shows very plainly the great value of experiments with kites. Those who have begun the study and designing of these state that the possibilities of their development are very great.

'*Class III.* Lilienthal machines. Mr. A. M. Herring, of New York,† has already begun to experiment with these, and there are others who intend to begin. Who knows but that Herr Lilienthal himself might be persuaded to make us a summer visit?

"*Class IV.* Experimental flying machines with motors.

"*Class V.* Meteorological experiments. The study of the wind.

"*Class VI.* Aerial screws. Screw-propelled bicycles.‡ Aeroplane bicycles. Testing of fabrics for aeroplanes and kites.§ Experiments to ascertain the solid of least resistance.‖

"During the evenings it would be interesting to have talks given upon various aeronautical subjects.

"Liberal prizes should be offered to those who excel in each class.

"Tent life on the Cape could be made quite agreeable.

"A restaurant tent, a workshop tent, and a large tent for evening talks would be necessary parts of the establishment.

"It would be desirable to build a conical hill such as Lilienthal has had made for himself.¶

"A large and level-boarded area with an incline for starting would be needed for bicycle experiments.

"I do not think there will be any great difficulty in raising the needed money.

"The first step to be taken would be to organize a National Aeronautical Association, and it seems to me the annual dues ought not to exceed $2 or $3.

"This scheme can be carried out if a sufficient number of men will volunteer to help in the elaboration of it.

"I am willing to take charge of the soaring-machine experiments and to superintend the raising of the funds.

"If those who are interested will volunteer in the other departments it will make the plan seem quite practicable.

"I shall be glad to have letters from any who wish to take part in study and work in this branch of science which they are likely to find of the most absorbing interest.

"James Means.

"Boston, Mass."

AERONAUTICAL NOTES.

Kress' Flying Machine.—A newspaper report emanating from Vienna states that at a recent meeting of the German Naturalists' Society a model of a flying machine constructed by Herr Wilhelm Kress was set in motion in the hall, and flew rapidly like a bird up to the gallery.

"Soaring."—It would seem as though the great scientific mystery of "soaring," about which so many books have been written, is about to receive a partial if not perfect solution. Mr. Potter, of Washington, D. C., has already perfected a kite of novel design, which mounts upon the "wings of the wind" and hovers directly over his head. This would seem to be almost a perfect imitation of the bird. The gravity of the kite and string act as the weight of the bird, and the peculiar spread of the kite acts like the wings, while the attachment of the cords serves to balance the kite. The great thing now is to perfect the balancing power, and to make a kite which will mount vertically upward. Mr. Potter is thoroughly alive to this question, and has now projected a kite with very flexible, almost movable wings. We may hope for interesting or even startling results.

* Published by American Engineer and Railroad Journal, 47 Cedar Street, New York. $2.50.

† See American Engineer and Railroad Journal, New York, pp. 50 and 51, January, 1895, number.

‡ It is highly important at the present time to have a bicycle made upon which different screws can be tested when worked by some record-breaking wheelman. In this way we can ascertain how many pounds of push and also of lift can be obtained for each pound of human motor when working under the most favorable circumstances.

§ It will be noticed that some of the experiments in this class can be made indoors when the weather prevents field work.

‖ See Sir George Cayley's article, pp. 47 and 48 of *The Aeronautical Annual* for 1895.

¶ See American Engineer and Railroad Journal, p. 578 of the December, 1894, number.

RECENT AERONAUTICAL PUBLICATIONS.

The Aeronautical Annual, 1895. Edited by James Means. Boston: W. B. Clarke & Co. 172 pp., 6 × 9¼ in., $1.

This new publication is apparently a labor of love or enthusiasm for the fascinating art of flying, or perhaps both. In an introductory note the author says : "If this compilation should happily bring any new worker into the field of aeronautical experiment, the hopes of the editor will be amply fulfilled.

"To ask questions of Mother Nature is delectable. If her answers be often non-committal, even such are lures to lead us into better questioning.

"The number of the *Annual* contains not much that is new, but divers things which, to use the words of an old compiler, 'do now for their Excellency and Scarceness deserve to be Reprinted.'"

The frontispiece of the book is a portrait of Leonardo Da Vinci, which is a fac-simile print from a drawing in red chalk by himself. The opening chapter is an account of his life, which is followed by some extracts from a treatise of his "Upon the Flight of Birds." As he died in 1519, this must have been written early in the sixteenth or late in the fifteenth century. The following extract from this old treatise sounds as though it had been part of the proceedings of the Aeronautical Conference held in Chicago in 1893. The distinguished author wrote about three hundred years before :

"When the bird makes his reflex movement above the wind, then he will mount much more than belongs to his natural momentum, seeing that he adds to that the help of the wind, which, entering under him, acts as a wedge. But when he has reached the end of the ascent he will have used up his momentum, and he will have remaining only the help of the wind, which would overturn him, because he strikes it with his breast, were it not that he lowers the right or left wing, which makes him turn to the right or to the left, descending in a semicircle."

After these extracts, three articles on Aerial Navigation, by Sir George Cayley, Bart., written in 1809 and 1810, and which first appeared in *Nicholson's Journal*, are reprinted. In the first of these the author considers the possibility of man flight, and makes observations which are startling to those of us who have thought that the principles of human flight have only been investigated recently. Thus he says :

"The idea of attaching wings to the arms of man is ridiculous enough, as the pectoral muscles of a bird occupy more than two-thirds of its whole muscular strength ; whereas in man the muscles that could operate on wings thus attached would probably not exceed one-tenth of his whole mass.

". . . . To produce this effect [the flight of man] it is only necessary to have a first mover which will generate more power in a given time in proportion to its weight than the animal system of muscles.

". . . . The whole problem is confined within these limits—viz., to make a surface support a given weight by the application of power to the resistance of air."

After describing some experiments which he made to ascertain the supporting power of aeroplanes, he says :

"Having ascertained this point, had our tables of angular resistance been complete the size of the surface necessary for any given weight would easily have been determined."

And again : "The flight of birds will prove to an attentive observer that, with a concave wing apparently parallel to the horizontal path of the bird, the same support, and of course resistance, is obtained. And hence I am inclined to suspect that, under extremely acute angles with concave surfaces, the resistance is nearly similar in them all. I conceive the operation may be of a different nature from that which takes place in larger angles, and may partake more of the principle of pressure exhibited in the instrument known by the name of the hydrostatic paradox ; a slender filament of the current is constantly received under the anterior edge of the surface, and directed upward into the cavity by a filament above it, in being obliged to mount along the convexity of the surface, having created a slight vacuity immediately behind the point of separation."

In his second article Sir George Cayley describes how the principles which he elucidated may be applied, and discussed at considerable length the question of stability, and in the last article the resistance and power required in both bird and

human flight. The discussion of these principles was thus much earlier than most persons suppose.

The articles quoted from are followed by a reprint of a treatise upon the Art of Flying by Mechanical Means, by Thomas Walker, portrait painter, Hull; a paper on Aerial Locomotion and the Laws by which Heavy Bodies Impelled through the Air are Sustained, read by F. H. Wenham, Esq., at the first meeting of the Aeronautical Society of Great Britain: some extracts from Franklin's correspondence referring to aeronautical matters are also given, and a number of old engravings are reproduced, showing early balloon ascensions. The other reprints are some descriptions of early ascensions by Montgolfier and others; a statement of Langley's law; Darwin's observations of the flight of condors and other birds in South America; an illustration of a machine patented by Mr. Henson in England in 1842, and John Wise's comments thereon; and various curious illustrations relating to aeronautics. The book ends with a Bibliography of Aeronautics, and comments and reports of experiments on the Problem of Man Flight, by the editor. In his comments he seconds the proposal of Mr. Chanute to organize an American Aeronautical Society, and suggests the establishing a camp every summer in some secluded spot where competitive trials of soaring or flying machines could be had. This idea Mr. Means has amplified more fully in the form of a circular, which is reprinted elsewhere.

The *Annual* is an interesting contribution to aeronautical literature, and should have the effect of attracting new workers into the field of aeronautical experiment, which is the object which the editor says he had in view.

Aerial Navigation. By J. G. W. Fijnje Van Salverda. Translated from the Dutch by George E. Waring, Jr. New York: D. Appleton & Co 209 pp., 4⅝ × 7 in.

The translator of this little volume says that it "contains a comprehensive summary, mainly in popular form, of the development of aerial navigation from the balloon of Montgolfier (1783) down to the early stages of the investigations and discussions of Langley, Maxim, Holland, and others." After the introductory chapter there is one on The Military Importance of Aerial Navigation, and others on Balloons for Buoys; The Air Ship in Calm Weather; The Extraneous Obstacles of the Wind; Practical Results already Reached in Machinery for Propelling Balloons; several chapters on the Flight of Birds, one on Atmospheric Currents, and Conclusion. The author aims, as his translator says, to give a summary of what has been done by other investigators and experimenters, and to show in patent phraseology the state of the art at the time he wrote. This is done with a considerable amount of that vague kind of speculation which is assumed to be aeronautical science, but which, it must be confessed, is often tiresome. A tolerably full account is given of the experiments with the balloon *La France* in 1884 and 1885, and in the last chapter the conclusions are stated that Giffard, in 1855, lengthened his balloon, which resulted in great difficulties and disappointments.

In 1872 Dupuy de Lôme made improvements with a view to increasing the stability of his balloon, and applied a small motor to it.

In 1883 Tissandier successfully increased the length of the balloon, and applied a propelling power to it.

In 1885 the balloon of Renard and Krebs "attained the important result that in seven ascents a return was five times made to the point of departure, showing that they five times had complete control of its direction.

Regarding flying machines proper, he concludes, "That a heavy flying machine must clearly be supported by an aeroplane of considerable dimensions, and that the construction of this aeroplane would have to be very strong; that a special motor will be required; that such an arrangement would be unstable; that aerial navigation has now assumed a really scientific character, and that rapid travel in the free air need encounter no serious difficulties—a series of conclusions which seem to be mere platitudes.

The latter part of the book is made up of more or less disjointed extracts from a later pamphlet of Mr. Fijnje, Professor Langley's writings, and an account of an absurd scheme for a flying machine described in *Cassier's Magazine*.

After going through this book the reader may be disposed to doubt the conclusions of the author "that aerial navigation has now assumed a really scientific character."

Atmospheric Resistance. Professor W. L. Webb. *Proceedings Engineers' Club of Philadelphia*, November, 1894. Gives results of tests to determine the resistance of air to the free fall of spheres.

A SNAP-SHOT AT AN ALBATROSS.

Snap-shot photographs have not infrequently added valuable facts to the stores of science. They are able to detect and analyze motions too quick for the eye to follow. A recent instance of the application of photography to settle a disputed question in natural history is an experiment made on a voyage from British Columbia to San Francisco by Mr. A. Kingsmill.

A large albatross had been following the steamer and keeping pace with it for several hours, and the wonder grew among the watchers on shipboard as to how the bird was able to fly so swiftly while apparently keeping its wings extended without flapping them. As this is a common manner of flight with the albatross, the explanation has been offered that the bird takes advantage of slight winds and air currents, and so is able to glide upon what might be called atmospheric slopes.

As the albatross sailed alongside of the ship, about 15 ft. away, Mr. Kingsmill snapped his camera at it, and obtained a photograph which astonished him and his fellow-voyagers.

The photograph revealed, what no eye had caught, the wings of the albatross, each some 5 ft. long, raised high above its back in the act of making a downward stroke. The explanation naturally suggested is that, more or less frequently, the bird must have made a stroke of this kind with its wings, although the eye could not detect the motion, and that the camera chanced to be snapped just at the right moment.—*Youth's Companion.*

We are inclined to place an interrogation mark (?) after this statement.—Editor Aeronautics.

Balloon Reconnoissance.—The other form of reconnoissance—aerial, that from balloons—has, whenever it has been found practicable, proved to be of the greatest value; but the tempestuous weather has prevented its frequent employment. On this account there is a dead set against balloons, and there are heard many growls against allotting any portion of our scanty transport for the carriage of that which can so seldom be used. If any one wishes to be convinced how penny-wise and pound-foolish we should be to abandon this but lately started form of reconnoissance, let him take the whole of the battles of 1870–71 and sit down and calculate not only what would have been the saving in blood, but in hard money if, on any one of those days, either side had been able to send up a balloon with practised observers in the car. It is because in peace time the inestimable value of information regarding the enemy's dispositions is not realized; it is because dispositions based on defective or incomplete information are not paid for as they are in war, with defeat and loss of lives, that soldiers fail to understand the full value of accurate information. Moreover, at Aldershot the balloon has never had a fair trial; it has been employed for mere tactical work and not for the manœuvring work, and this because the latter has not existed. It is sent up simultaneously with the advance of the troops to the battlefield instead of being sent up at daybreak to obtain information as to whither that advance should be. When our training resembles the work of modern war, and when manœuvring occupies the foreground, loud will be the demands for a balloon. But even when used tactically it has been a success. At the operation near Chobham Ridges on July 25 the balloon observers reported to the attacking force an approaching strong counter-attack. So little did the general know of his enemy's dispositions that he would not believe the report. Shortly afterward, however, the counter-attack took place. On two other occasions the balloon observers kept their side constantly informed of the dispositions of the hostile forces in the battle. The balloon now works in conjunction with the field telegraph; written reports are passed down by "messengers" along the cable of the captive balloon to mother earth, where a telegraph station is ready for their reception. The other end of the telegraph wire has been carried to the point in the battlefield where the general has taken up his stand; if he shifts, the wire is laid on to his next position, so that the balloon itself can remain well in the rear of the fight and yet communicate rapidly with the commander. It may be here mentioned that another form of aerial reconnoissance is in the experimental stage; it consists in raising the observer by means of a kite, the contention being that the worse the weather for the balloon, the more suitable it is for the kite. Both Lieutenant Baden-Powell, of the Scots Guards, and Captain Pilcher, of the Northumberland Fusiliers, are engaged on working out this problem, each in his own way, but at present neither solution has reached the practical stage.—*London Times.*

AMERICAN ENGINEER AND RAILROAD JOURNAL.

Formerly the RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

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NEW YORK, APRIL, 1895.

EDITORIAL NOTES.

THE international exhibition seems to be the order of the day. Even before the Chicago Exhibition was fairly under way, France announced the undertaking of another, and preempted the year 1900 for that purpose; then hardly had the gates of the White City been closed before the Midwinter Fair at San Francisco was in full blast. Antwerp followed last summer, and Atlanta is now in the throes of preparation for the Cotton Exposition of the coming fall. Then the *débris* will hardly have ceased to attract attention before Mexico will have opened her first show, provided things move as the promoters wish. This invasion of the Spanish American countries by the international exhibition has not yet been fully decided, but it is safe to say that the country having once been inoculated, the fever will not be allayed until it has run its course and ended in a fizzle or a success.

THE discussion on Rapid Transit by the Mechanical Engineers of New York seemed to swing around the civil engineering portions of the problem, and only at the latter portion of the discussion was the expense of operation touched upon. Each speaker seemed to take it for granted that the coming rapid transit railroad must be constructed *de novo*, and that an increase in the facilities of the present roads could be ignored. As a matter of fact, the West Side lines of the Manhattan are capable of a considerable increase in capacity. Even with the present third-track facilities, express trains run from Rector to One Hundred and Twenty-fifth Street in 29 minutes; and were the third track to be extended down Greenwich Street to Franklin, the time could probably be reduced to 20 minutes, and by running through trains over the Putnam Division of the New York Central & Hudson River Railroad it would be possible to run from Yonkers to Rector Street in 40 minutes. Five car trains running on 1½ minutes' headway would provide for 160 seated passengers per minute, which would afford a great relief to the local trains, and cut down very materially the number of standing passengers who take the cars below One Hundred and Fourth Street or above Franklin. The structure is strong enough to carry the extra track, and we understand that the plans are prepared; but unless the stories told by the railroad officials are very far from the facts, the city authorities have interposed every conceivable obstacle to the laying of this third line of rails.

THE interesting correspondence which we publish in another column suggests and probably explains the reason why steel tubes have shown a more rapid corrosion than iron in steam boilers. It would add greatly to the information which we have upon the subject of boiler corrosions if some one would carry out a series of experiments to determine whether there is any basis to the assumption that metal corrodes more rapidly when under a tensile than when subjected to a compression strain. It has been suggested that this is the reason why the tubes of water-tube boilers corrode more rapidly than those of fire-tubes, and there seems to be some good reason why this should be so; but we are not aware that any one has investigated the question to such an extent as to be able to state whether a tensile strain actually does promote corrosion, or whether the theory that it does is merely a shrewd guess to account for a known phenomenon.

THE NARROW-GAUGE DELUSION.

THE English papers for some months past have been filled with discussions, reports of conferences, and communications on the subject of "light railways." The public in England seems to be agitated on the subject of providing better facilities of transportation for the rural districts of that country, with the hope that such facilities may do something to relieve the agricultural distress, which prevails there as it does in other parts of the world. The question of the relation of the gauge to the cost of construction and operation of light railroads is again very warmly discussed, and the same old arguments that did service in the old "battle of the gauges" of half a century ago, and again in the later one 25 years afterward, are repeated, and are disputed as warmly now as they were then. Few are now living who remember the earlier battle, and since the later controversy a new generation of engineers and railroad men have come on the field, who know little or nothing of either campaign. A retrospective view may therefore have some interest, especially to our younger readers.

The first "battle of the gauges," as it was called, was fought about 1845, and the question at issue then was, whether gauges *wider* than 4 ft. 8½ in. were more advantageous than the latter; but in 1870 the issue was between the 4 ft. 8½ in. and narrower gauges. We have before us the Report of the Commissioners appointed by Parliament to "inquire into the Gauge of Railways," with the minutes of evidence taken before the Commissioners. This forms a large volume of 850 pages, which if one had an unlimited amount of time would make very interesting reading. When this report was made some of the English roads were of the standard 4 ft. 8½ in. gauge, while others were of 6 ft., and the Great Western 7-ft. gauge. For the latter it was claimed:

1. That the cost of the locomotive power is reduced by using engines of large power and capacity for steam.
2. That such power can only be obtained to the required extent, and be economically applied by the adoption of the broad (7-ft.) gauge.

3. That higher speeds can be, and are, obtained by the broad gauge, and with greater loads.

4. That the plant necessary to work a given amount of traffic is less costly, in proportion to the amount of such traffic, in the first instance, and there is a corresponding less dead weight carried.

5. That by the use of larger and heavier carriages, and the greater width of base, there is greater security, as well as superior accommodation, with the means of combining the conveyance of all classes by the quick trains, which has not been found practicable on any narrow-gauge line.

In his testimony before the Commission, Mr. Brunel, the Engineer of the Great Western Railway, said that he "would rather be above than under 7 ft. now, if he had to reconstruct the line." But notwithstanding all the evidence which was brought forward in favor of the wide gauge, the decision of the Commissioners and of subsequent events was against gauges wider than 4 ft. 8½ in.

About 1870, however, Mr. R. F. Fairlie read a paper before the British Association on "The Gauge for Railways of the Future," which to a very great extent was based upon the proposition which he announced that "the proportion of non-paying to paying weight (as far as this is independent of management) is increased exactly in proportion as the rails are further apart, because a ton of materials disposed upon a narrow gauge is stronger as regards its carrying power than the same weight when spread over a wider basis." Now if this proposition was true, it would follow, logically, that a bicycle or a wheelbarrow would be imponderable. From the hypothesis—for it was nothing more—which we have quoted, Mr. Fairlie attempted to show that railroads with gauges narrower than 4 ft. 8½ in. would have immense advantages, and be much more economical to construct and to operate than standard gauge roads. He set forth his arguments in a very alluring way. His paper was republished in every part of the world, and his assumptions and conclusions were, with one exception, generally accepted by all the engineering and railroad papers in this and in other countries. The paper created a furore everywhere. It appeared at a time when the investing public had become distrustful of railroad securities, and it at once was taken hold of by projectors, promotors, and schemers of every degree of veracity and mendacity. The new doctrine was proclaimed in defiance of the laws of statics and gravitation, and the pill was swallowed by investors, many of whom were very much nauseated thereafter. A great many narrow-gauge roads were projected and built in this and in other countries. Here nearly all of them have since been changed to standard gauge at great cost and an immense waste of money.

The exception among the papers referred to above was the *Railroad Gazette*, of which the writer was then an editor. It republished Mr. Fairlie's paper, with a criticism of it, pointing out that his new mechanical principle was a fallacy and his conclusion nonsense, and that the gauge of a railroad had very little and within practical limits perhaps *no* influence on the weight of rolling stock. Week after week that paper pointed out the errors and delusions of the advocates of the narrow gauge. Their facts were disputed and their arguments dislocated, but still those who "were convinced against their will were of the same opinion still," and kept on building narrow-gauge roads, until the irresistible logic of events made the delusion apparent and the bubble burst. During all this period the paper referred to stood like a stone wall, exposed the fallacies of the advocates of the new system, resisted the obloquy and the ridicule which was heaped upon it by its contemporaries, and the promoters of the "new system." The technical press of the whole world were unanimous in their acceptance of the new plan of railroad salvation, which, like the road which leads heavenward, they insisted must be a narrow path. The *Railroad Gazette* was then the only paper to dissent from the new faith, which was preached so zealously and practised extensively. Which was right and which were wrong events have since decided. In the light of the experience in this and other countries, it seems strange to see the old well-worn and threadbare facts and arguments again paraded, with all their tatters, in the papers of to-day. Recalling the controversy of a quarter of a century ago, the fallacies of that day have a sort of mouldy flavor when they are repeated in print, as they have been in late English papers. A short review of the arguments used in the old controversy may be entertaining and perhaps profitable to some readers.

It may be said, as a preliminary observation, that no argument is needed to prove that a wide-gauge road laid with heavy rails and equipped with heavy rolling stock will be more expensive than a narrow-gauge line with light rails and light rolling stock. In England the question which is now being discussed anew is whether the cost of light roads will be materially less if the gauge is made 2 or 3 ft. instead of 4 ft. 8½ in.?

Mr. Fairlie's fundamental proposition, and it was accepted by most of the narrow-gauge disciples, was that "the proportion of non-paying weight is increased exactly in proportion as the rails are further apart." On this hypothesis, if we let W represent the non-paying weight, G the gauge, and n an undetermined quantity, we will have

$$W = G \times n.$$

For a 3-ft. gauge $W = 3 \times n$,

and for a 6-ft. gauge $W = 6 \times n$.

But for a single-rail line $W = 0 \times n = 0$,

which proves that, as remarked before, a bicycle and a wheelbarrow would have no non-paying weight, or be imponderable.

The question may also be considered in a different way. Let it be supposed that fig. 1 represents a side view of a freight box-car for a 3 ft.-gauge road, and that fig. 2 represents an end view of this car. It will be supposed, further, that the body, B, is made of such dimensions, weight, and strength as are best suited for the traffic on a light, narrow-gauge line. The width, it will be assumed, is double the gauge, or 6 ft., and the length, 28 ft., although any other dimensions may be adopted if they are desirable. Now, suppose that such a body, instead of being carried on two 3-ft. gauge trucks, or "bogies," is mounted on trucks of 4 ft. 8½ in. gauge; obviously the carrying capacity, strength, and weight of the body will be the same in each case, so that neither gauge will have the advantage so far as the body is concerned. It is also plain that the wheels and side or longitudinal frames of the trucks could be the same, and would have the same carrying capacity on either gauge. The only difference in the trucks will be in the length, size, and weight of the transverse members—that is, the axles, bolsters, transoms, and brake-beams. These, being longer, must also be of larger cross-section and consequently heavier. The weight of the car would be increased only in those parts, which would be very little. Whatever it is should be credited to the narrow gauge; but there should be an entry on the other side. It is generally considered inadvisable to make a car-body of a greater width than double the gauge. This principle will limit the width of the car-body on the narrow gauge to 6 ft., but on the wide gauge it might be made more, say 8 ft. The aggregate length of the sides and ends which enclose the 6-ft. body is 68 ft.; the floor area, 168 sq. ft., so that each foot in length of what we will call the walls of the car encloses 2.47 sq. ft. of floor area. In the 8-ft. body the length of the walls is 72 ft., and each foot encloses 3.11 sq. ft. of floor. It will thus be seen that the wider body will be lighter in proportion to its carrying capacity than the narrower one. The argument would be just as applicable to cars carried on four wheels, as English "wagons" are, as it is to "bogie" rolling stock. It sometimes seems, though, as if a surgical operation were required to get into the heads of narrow-gauge advocates the idea that light cars and engines may be used on standard

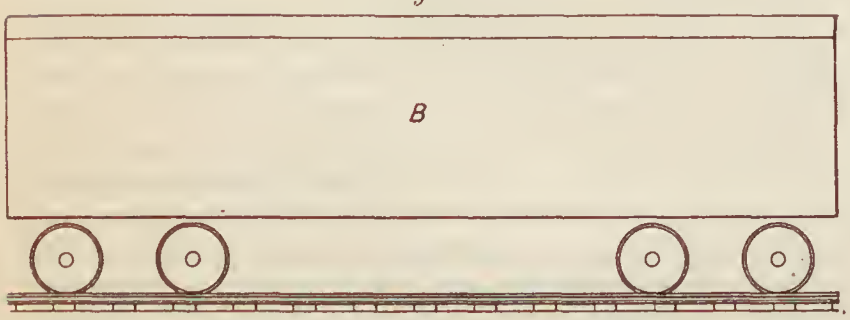
gauge roads. That they can be is shown by the fact that the lightest cars which are used—those for horse railroads—are almost invariably made of standard gauge.

Locomotives need hardly be discussed. All that requires to be said is that with the same capacity, the same sized boiler, cylinders, and wheels the difference in weight will be almost inappreciable, and the price will be the same. Any locomotive builder who understands his business will confirm this statement, and any of them will build engines of the same capacity, size and weight for the same price for either gauge.

If, then, the rolling stock is of the same weight, the rails need not be any heavier on a wide than on a narrow-gauge road; all arguments based upon the assumption that lighter rails can be used on the one gauge than on the other are simply imbecile.

But it was and is still argued by some that the width of cuts and embankments may be less with a narrow-gauge than with a wide one. Let us analyze this claim. If a road is to be cheap it will be unballasted, and the sleepers or cross-ties will rest directly on the earth. On such yielding material there must be sufficient bearing surface to carry a given weight. If the weight of the rolling stock is the same on each gauge, the bearing surface and consequently the length of the sleepers may be the same. When 3-ft. gauge roads were first built in this country, sleepers 6 ft. long were laid,

Fig 1.



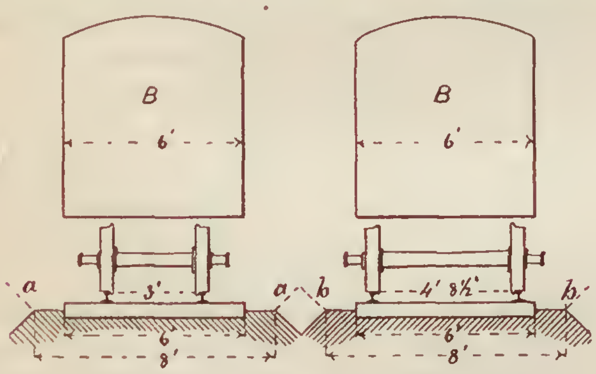


Fig. 2. *Fig. 3.*

but it was soon found that on what is not inappropriately called a mud road, that in order to get sufficient stability their length had to be increased. It may be assumed as a fact that a 3-ft. gauge road cannot be operated satisfactorily with sleepers shorter than 6 ft. Now it is quite practicable to lay a 4 ft. 8½ in. gauge road on 6-ft. ties, as shown in fig. 3, and if they are made longer than that, as experience has shown is essential, we approximate to what has been common practice on many of our earlier and cheaper 4 ft. 8½-in. gauge lines in this country. In other words, the length of the sleepers does not depend upon the gauge, but on the load they must carry.

It is also true that the width of embankments is not governed by the gauge, but by the length of the sleepers. If the latter must be as long for the one gauge as for the other, the embankments may be of the same width for each.

But the narrow-gaugers say you can run around sharper curves if the rails are near together than is possible if they are wider apart; and, as a writer in *The Times*, Mr. Calthorp, said some time ago, "the direct saving of a narrow gauge as regards earthwork occurs through the greater flexibility of its alignment, which enables it to wind in and out, to avoid the severance of valuable property, deep cuttings, heavy embankments, and, if required, to follow all the convolutions of an ordinary road." The force of this argument depends upon the main assumption, which is that you can run around sharper curves with a narrow gauge than with a wide one, which is denied. The shortness of the radius of curvature is dependent upon other considerations, and not on the gauge, and, as a matter of fact, it is not true that curves of shorter radius are used on narrow-gauge roads than on those of the standard distance between the rails. Mr. Calthorp, who was formerly employed on a road in India, in the same article from which we have already quoted says that the minimum radius of curvature on the main lines of 5 ft. 6-in. gauge roads, in that country, is 1,600 ft.; on metre-gauge roads, 1,000 ft.; on 2 ft. 6-in. gauge, 250 ft.; on 2-ft. gauge, 150 ft. On the New York Elevated railroads, which are 4 ft. 8½ in. gauge, and on which more trains are run per day than on any other road in the world, there are curves of 90 ft. radius on the main line, and all trains must and do run over them. It is, therefore, not true that shorter curves are used on narrow than on wide-gauge roads, and all arguments based on such an assumption fall to the ground.

In his article in *The Times*, Mr. Calthorp says further: "It is a well-known fact among locomotive engineers, that on the same gradients a narrow-gauge locomotive, in proportion to its weight, can haul a larger load than a standard-gauge engine, the advantage being still more noticeable when the gradient occurs on a severe curve." This illusion, it was thought, vanished 25 years ago, when it did duty, and we were accustomed to it; but to see it in print again leads one to doubt the observation that the "world do move." Some evidence ought to be brought forward to show why the law of gravitation acts differently on a narrow than it does on a wide gauge before this statement can be accepted.

It may, in conclusion, be asserted with great positiveness: 1. That neither rolling stock nor rails can be lighter or cheaper for narrow than for wide-gauge railroads *for the same kind of service.* 2. The sleepers for rolling stock of a given weight must have the same amount of bearing surface and be of the same length for both gauges. 3. The embankments must therefore be of the same width. 4. Narrow-gauge cars and locomotives do not run around sharper curves than those of standard gauge do, and therefore narrow-gauge roads have no greater "flexibility of alignment" than wide ones. 5. The law of gravitation acts in the same way on rails placed 4 ft. 8½ in. apart as it does when they are 3 ft. or not so far apart, and therefore a locomotive of a given weight will pull as much on the one gauge as it will on the other. 6. The idea that placing the rails nearer together lessens the cost of construction, lightens the rolling stock, and diminishes the expense of operating a railroad is an exploded delusion. 7. A road for light traffic can be built and operated as cheaply, if made of the standard gauge, as it can if the rails are placed nearer together. This is proved by the fact that horse and electric roads are almost universally made of the standard gauge. 8. If rails are laid on common roads, it is important that two horses may be able to travel side by side between the rails, which they cannot do if the rails are nearer together than 4 ft. 8½ in. 9. It is fatuitous to cite the difference in cost between wide-gauge roads, with heavy rails and rolling stock, expensive stations, and other equipment, and that of narrow-gauge lines with light rails, light cars, light engines, and cheap stations, signals, etc., and reason therefrom that the difference is due to the gauge. It would be just as unreasonable to take the difference in cost between a big house built on a wide street, and compare it with that of a small house

on a narrow street, and infer therefrom that it is much cheaper to build houses on narrow streets than on wide ones. 10. Some thousands of miles of light 3-ft. gauge railroads were built in this country, nearly all of which have been changed to the standard gauge at much cost and inconvenience, which ought to be a conclusive argument.

"LOCOMOTIVE RETURNS."

In February, 1892, we commenced the publication of the tabular "locomotive returns," which have been published each month since that time. In announcing our intention of publishing these tables, it was said : "Comparative statements of this kind cannot fail to bring out some interesting points, and they may perhaps do the further service of impressing upon those in authority how desirable it is to have a uniform system of estimating and stating locomotive performance."

During the latter part of the period—now nearly three years —that those returns have been published, we have had serious doubts whether they were accomplishing what it was hoped they would when they were first announced, and whether they were of any considerable value to those for whose benefit they were especially intended. As they occupied, each month, a whole page of our space, which could be devoted to other interesting matter of which there is always a surplus, and as tabular typography is considerably more expensive than ordinary reading matter, we have been led to consider whether the space given to these returns might not perhaps be more advantageously devoted to other subjects. With this object in view, a copy of the following circular letter was addressed to all the Master Mechanics and Superintendents of Motive Power who supply us with their reports :

Dear Sir : For several years past we have been publishing each month in tabular form the locomotive returns of some 33 railroads. As there is considerable extra expense attending this publication, and as we get very little indication that our readers are interested in these returns, I have been led to write to some of the locomotive superintendents to inquire whether these returns, as published in The American Engineer, are of any value to them. If not, we could devote the space to other and perhaps more interesting matter, of which there is always an abundant supply. I would be much obliged if you would give your opinion frankly with reference to the advisability of the continuance of the publication of these returns.

In response to this 20 replies were received, in seven of which the writers said that they considered the returns as published in these tables were interesting and valuable, and expressed the hope that they would be continued. Thirteen of the writers thought the returns were of comparatively little value or interest. The following extracts from the letters will give a good idea of their tenor :

"It is, to my mind, questionable whether these returns as here given are of any real value. Each road works out its performance sheet and gets its percentages and averages independently, and there is no accepted standard to which to refer. To illustrate : on our road every shop expense for new tools, renewals, extraordinary expenses of all kinds are charged to supervision account, and divided *pro rata* among the regular accounts for the month, increasing them just that much. With my old friend Mr. ——, of the —— Railroad, however, the tool account is kept separately, and charged off to profit and loss at headquarters at the end of the year. Again, with us the oil and waste used by wipers is a factor in the 'Cleaning and Watching Account,' prorated according to the mileage among all the engines, while on the —— each engine is charged with the oil and waste used on it by the wipers, which goes thus to swell the oil account. Under circumstances of which the above are samples it is hard to make any comparison from these tables, or at least comparisons of any great value. Still, however, I should be very sorry to see this table done away with, as it gives me a slight idea at least of what the outside world is doing."

"I consider these reports of great value, and I believe that they are quite generally read. I would dislike very much to see them discontinued.

"I have at times taken a very great interest in a comparison between our own and the returns of other roads, and when such comparison was unfavorable, it was a stimulant to us to try and do better ; and when the showing was better than other roads, it was very gratifying for us to have this information. If the matter were left to me as to whether or not this statement should be left out, I should say, leave it by all means.

"I never fail to look over these returns myself, and take considerable interest in them. I only wish the figures on other roads were given for cost on car mileage, which would make them of much more material value.

"I have looked for it each month for the purpose of making comparisons, and, by the way, have felt somewhat gratified at the showing of —— in number of tons of coal burned per train-mile, as compared with some of our Eastern friends, in view of the fact that we have heavy mountain grades on all three of our main lines. So far as I am personally concerned, I really think the publication of these statements is of great interest.

"For myself, I carefully look over that statement each month in order to see how our expenses compare with other railroads, and as far as I am individually concerned, I would be glad to see the publication of the statement continued."

"To me the returns have always been one of the points of interest in your paper. I only wish the table was more complete, showing all the large railroads in the United States, and I further wish that the performance sheets were all based on a given unit of work, and the grades and curvature of the different roads reduced to an equivalent of straight and level track, so that the report would be more intelligible and more useful than at present ; but even as it stands, I do not know of any more interesting information than you could put on the page now occupied by this table."

"I have taken considerable interest in watching the locomotive returns which you publish, but it is a difficult matter to obtain any definite information on this point that would be comparative, as the circumstances vary so.

"It would seem to me until the locomotive reports are all made on the same basis all over the country, you cannot get an intelligent idea of the cost of locomotive performance.

"Personally I should prefer to have it omitted, substituting therefor other good reading matter, with which your journal is replete.

"The conditions are so different on different lines of railroad in the United States, one getting its coal at a very low price, and another at a high price, one getting its labor at a less rate than another, and so on, that it does not seem to me there is really a large interest taken in such returns, and the space could be used to better advantage.

"I am of the opinion that the space thus occupied might be devoted to more valuable matter, and I believe would be of much more interest to the readers.

"The more we have tried to use them for purposes of comparison between our practice and that of other roads, the more we have been confronted with the fact that different roads make up these returns in different ways ; that it is almost impossible to get them down to any uniform basis, and that on that account these comparative performance statistics are almost sure to be misleading. Since we reached that conclusion we have not, ourselves, placed as much dependence on the figures published in your paper as we had previously

done. Therefore, our vote would be that, everything considered, it would not pay you to further continue the publication of these returns."

"I do not believe these returns are of any interest to your readers outside of those connected with the roads reporting, and while it affords me a basis of comparison, and is to this extent interesting, it would be rather selfish on my part to urge their continuance, if, as you say, the publication is attended with extra expense, and, no doubt, the space could be devoted to a matter of more general interest. I think, therefore, you would be justified in their discontinuance."

"There is such a wide difference on various roads in the method of keeping motive power accounts, also such a wide difference in the conditions of service, class of equipment, etc., on different lines, that, in my opinion, so long as these variations exist, it is not practicable to make reliable comparison between the performance on different roads in the country. The information on this subject that you have published in your paper is interesting to look over, and for the purpose of comparing the performance on one line of road from month to month; but as a comparison with different roads, I do not consider the reports reliable for reasons previously explained."

"We exchange performance sheets with all of the leading roads in the country, and I presume most of the other roads are doing the same; consequently the publishing of these sheets in The American Engineer is of little interest to us."

"I don't think that there is much interest taken in the locomotive returns referred to. They are not practical, as the systems of calculating mileage of switch and other engines are not uniform, and for other reasons I would cut them out for more interesting matter."

"At first I took considerable interest in the statements in tabular form of locomotive returns from some 33 railroads published in your paper monthly, but as the system of keeping accounts is entirely different on the different railroads, the results shown in your paper are not comparable. For instance, on the —— the salaries of the Master Mechanic and his force are charged to the expenses, and not shown under repairs of locomotives and cars. Under our system the salaries of the Master Mechanic's force and a portion of salaries of the Superintendent of Motive Power and his force are charged up to the repairs of locomotives. It would seem to me, therefore, advisable to drop this statement from your paper."

"I don't think the publishing of the monthly returns of locomotive performance sheets amounts to anything. I never look at them, and don't pay any attention to them. We do this because we feel well satisfied that there is nothing comparable about them. It is well known that even on a series of divisions of a large railroad such comparisons are eminently unfair. Take, for instance, on the ——, the —— Division will always show better results per mile run than any other division of the system, and this regardless of whether there is a first-class man in the Master Mechanic's chair or a very indifferent man. The good results obtained on the —— Division are due entirely to the natural physical condition of the road, and it is folly for any other road in the system to compete with it. We could make the same criticism in regard to the divisions of the——. I think the fairest and most interesting way to show what a railroad company is doing is to publish its performance for a term of years and then to make, or to require explanations to be made, explaining why the decreases occur or why the increases occur."

This testimony has led us to conclude to discontinue the publication of the returns. We shall, however, return to the subject again, and may endeavor to point out how a system of keeping locomotive returns might be devised which would make them comparable.

NEW PUBLICATIONS.

The Pocket List of Railroad Officials. Containing the Names of Officials in Charge of Railroads, Private Car Companies, Fast Freight Lines and Transportation Companies of the United States, Canada and Mexico. Also Showing the Gauge of each Road, Number of Miles Operated, and Rolling Stock in Service of each Company. New York: Published quarterly by the Railway Equipment & Publication Company, 326 Pearl Street. 292 pp., 4 × 6 in.

Most persons whose business brings them into relations with railroad officials have felt the need of some convenient directory of the names, addresses, etc., of such persons which may be conveniently carried about. Such a volume is provided by the "Pocket List" before us.

Besides the usual list of officers for each road, which is given in similar guides, this contains a table showing miles operated, gauge and rolling-stock equipment of the railroads and private-car lines, which is a new feature.

An alphabetical list of officials is also given, in which their names, titles and the record number of the railroad with which the official is connected. This record number precedes the name of the road in the regular list of roads, which are arranged alphabetically. It is, therefore, easy to refer to the number, which gives the name of the road.

There is also a list of places which are the headquarters of railroad officials. These are arranged alphabetically under the name of each State, the latter being also arranged alphabetically.

A list is also given of the names and location of the national and State railroad commissioners, including Canada. The names of the officials of each road, when there are several officers, are classified and their names placed alphabetically, which facilitates the finding of the name of a person desired.

The list is a very complete and convenient one, and is quite sure to be popular, especially among those whose duties lead them to travel to and fro in the land seeking whom they can sell supplies to.

The only feature about the book that seems to require criticism is its binding. This is done with wire, and so securely that it is difficult to open the book so as to be able to see the inner portions of the page, which is exasperating. The publishers ought either to improve the binding or furnish a small "jimmy" to each of its readers, to enable them to pry it open. If it is to be used as a travelling companion the covers should also be made of some more substantial material than stout paper.

Theoretical and Practical Ammonia Refrigeration. A Work of Reference for Engineers and Others Employed in the Management of Ice and Refrigeration Machinery. By Iltyd I. Redwood. New York: Spon & Chamberlain. 146 pp., 4¾ × 6¼ in.; $1.00.

"Freezing machines," the author of this little book says, "are now coming so generally into use in large factories and manufacturing establishments where natural ice was formerly employed, that they are of necessity placed, directly or indirectly, under the supervision of men who, owing to the comparative newness of the subject of ammonia refrigeration in relation to the manufacturers, cannot be expected to be thoroughly conversant with their theoretical and practical working.

"It is with a view to giving those connected with the running of ammonia refrigerating plants a more intelligent idea of what they are doing that this book has been written."

With this object in view the author begins with explanations of some of the elementary principles and terms which relate to the science and art of refrigeration. The second chapter is on the theory of refrigeration by compressed air and ammonia, and in it the characteristics of ammonia are described. Chapter III contains a description and engravings of a refrigerating plant, both of which it is thought might have been more full and complete with advantage to the reader. In the fifth chapter various appliances used in connection with refrigerating plants are described, and in the remaining chapters contain explanations and directions for the management of refrigerating plants. A good index completes the book, which will doubtless be very acceptable to large numbers of people who are concerned in the management and use of the class of machinery to which it relates.

The Memphis Bridge. A Report to George H. Nettleton, President of the Kansas City & Memphis Railway & Bridge Company, by George S. Morison, Chief Engineer of the

Memphis Bridge. New York: John Wiley & Sons. 74 pp. of text, 60 plates and 6 full-page photographic views of the bridge during erection and on completion. Size of pages, $13\frac{1}{2} \times 22$ in.; $10.00.

The report before us forms one of a number of magnificent albums which Mr. Morison, now the President of the American Society of Civil Engineers, has published, and in which he has described the different bridges of which he has been the chief engineer. The report is prefaced with a large engraving made from a photograph showing the bridge as it appears on completion. The report itself contains: I, A Preliminary Narrative, giving an account of the origin and history of the bridge, and the legislation and corporate action which led to its construction; II, A General Description; III, A Detailed Description of the Substructure, in which each pier is described separately; IV, A Description of the Superstructure, Material, Contracts and Contractors, Erection and Weights of Superstructure; V, A Description of the West Approach Viaduct; VI, The Approaches; VII, The Shore Protection; VIII, The Cost; and lastly Appendices, giving a list of the names of engineers, employés and contractors; acts of Congress; contract with the War Department; reports of February 15, 1887, and August 2, 1888; argument for the amendment of charter; local ordinances; tables giving the time, cost and materials used in foundations; other tables giving the records of the sinking of the caissons; specifications for masonry and superstructure; descriptive tables of tests of steel eye bars, and report of Testing Committee.

Besides the view of the completed bridge, there are six views showing the process of sinking the mattress of pier II; a large view showing the east portal of the bridge; another of the traveller used on the east end; other views showing the east intermediate span during erection; the west approach.

The sixty lithographed plates consist of, first, two excellent maps showing the location of the bridge; a profile showing its vertical alignment; a general elevation and plan; a profile showing the stratification below the river on the bridge line; two diagrams indicating the height of water during 1886–92; graphical records of soundings of the river and views of the east abutment. This is followed by 19 plates showing the construction of the caissons and piers and the appliances used in putting them down. Twenty-eight sheets represent the superstructure, and a number more relate to the approaches. All of these are admirably drawn, and show the whole structure in great detail and in the most complete manner. The report, like all that Mr. Morison has issued, is a model of its kind and is one which will be a work of reference for all time, or as long as wood-pulp paper will last.

Les Reformes des Tarifs des Voyageurs. By L. de Perl. Paris: J. Rothschild. 279 pp., 6×9 in.

The reformation of passenger tariffs, in regard to which this work is especially directed, refers more particularly to a careful investigation of the results obtained in the working of the Hungarian zone system. In fact, the Russian Minister of Finance, who appointed M. de Perl to make the report of which this book is the embodiment, merely contemplated at first an investigation of the change in passenger tariffs that has been adopted by the Hungarian government, with the view of determining whether or no it could be applied to Russian railways. After setting about this work, it soon became evident to the author that an investigation of the general conditions controlling passenger tariffs throughout the several countries of Europe would be required. This was done, though the author does not lose sight of the fact that the Hungarian zone tariff is to occupy the principal position in his report. In reading the book one has the feeling that it is written by a man who has made a thorough and careful study of the subject, but who is not altogether familiar with it from the standpoint of a man who has had to do with the adjustment of rates in actual practice. This does not imply by any means that the conclusions reached by the author are not worthy of the highest consideration. He gives a rapid review of the conditions of passenger rates in nearly all the countries of the world; compares and checks off the privileges accruing to purchasers of different classes of tickets. As an example of his method of working, we give the headings of the paragraphs of the chapter devoted to the United States: Rates in Operation on the Railroads of the United States; Commutation Tickets; Mileage Tickets; Baggage. After a careful review of the work done and the results accomplished by the Hungarian zone tariff, the author comes to the following conclusions:

1. Minister Baross, independently of his politico-economical objects, has hit upon a happy means of adding to a traffic that seemed to have touched its highest notch, proving that even in a sparsely populated country it is possible to develop a traffic that it would naturally seem impossible to increase.

2. The principal object for which the zone system was introduced—namely, that of increasing long-distance travel—has, in fact, not been accomplished; not only has the average distance travelled per passenger not increased, but it has actually fallen off from 36.6 miles to 25.5 miles. Although the distance travelled by passengers on express trains has risen from 48.5 miles to $63\frac{3}{8}$ miles, it must be remembered that the number of passengers carried on these trains amounts to only 5 per cent. of the whole, and that the increase in the number of long-distance travellers has been obtained by making better connections with other lines.

3. By abolishing the third class on express trains, passengers who usually travelled at this rate were driven into the second class.

4. Not only has the hope of seeing passengers from the lower classes take the higher not been realized, but, on the other hand, the number of third-class passengers has actually increased, to the detriment of passengers of the two upper classes.

5. The improvement in the loading of cars, which was estimated at 10 per cent., has not been realized on account of the limited number of cars in the trains, as well as by the crowding of passengers in the cars. Even though they might increase the number of trains and the number of cars in a train, the utilization of the places could hardly be improved more than 5 per cent.

6. The increased value of the movement of passengers, where the traffic is about up to its limit in the central zone, is to a great extent absorbed by the few passengers going between zones II and XII. As for the hope of maintaining or increasing the travel and receipts in zones XIII and XIV in the future, it is very doubtful whether it can be done. It is difficult to suppose that the tendency of the Hungarians to visit the capital will keep up to the present standard in the future, when the first influence of the reduction of rates is not felt. For tourists and the general traveller this city has no attractions which the other European capitals do not possess.

7. The doing away with the free transportation of a certain amount of baggage has not exercised, in spite of the increased traffic, the favorable results on the receipts of this department that were expected, while the cars are encumbered with the great quantities of luggage, that passengers persist in carrying in their hands.

8. The net benefit of the system adopted by the managers of the Hungarian State railways is not such as to lead one to believe in the utility of the zone system of tariffs. And one can assert with certainty that the increase in receipts obtained from an increase in the traffic near the capital is insufficient to cover the loss in receipts in the more distant zones; that the cost per passenger will exceed the receipts, and that the adoption of the zone system will always result in loss.

Practical Application of the Indicator with Reference to the Adjustment of Valve-gear in all Styles of Engines. By Lewis M. Ellison. Published by the Author, 25 West Lake Street, Chicago. 197 pp., 6×9 in. $2.

In his preface the author of this book says that in the practice of his occupation—that of a consulting engineer—he found many engineers (that is, men who run engines) who have expressed a desire to learn the use of the indicator. In recommending various books to such persons he found that there was a very general complaint that they were not sufficiently *definite* (probably *lucid* is what is meant) for the beginner. This experience, and the fact that he himself has felt the need of more practical information on the subject, led him to the effort to produce a "work which will meet the requirements of the beginner as well as the experienced engineer," which was certainly an excellent motive. Of his qualifications for carrying out such an undertaking his book must testify. There is abundant evidence all through it that the writer possessed the knowledge and experience needed for his task; but something more than this is needed to write such a book as he aimed to produce. To quote again the words of Huxley, which perhaps cannot be repeated too often: "Good exposition implies much constructive imagination. A prerequisite is the forming of true ideas of the mental states of those who are to be taught; and a further prerequisite is the imagining of methods by which, beginning with conceptions they possess, there may be built up in their minds the conceptions they do not possess." The distinguished author says further: "Of constructive imagination as displayed in this sphere, men at large appear to be almost devoid." It is in this direction and not in a knowledge of his subject that the author seems to be deficient. If, as he says, his aim was to "produce a work

which will meet the requirements of the beginner" who desired to learn the use of an indicator, it would seem as though an absolutely essential feature would be to explain with the greatest clearness and fulness the purpose for which indicators are used, and their construction and operation. It is of the utmost importance that a beginner should know how an indicator is made and what it is for. Now the only description of it in the book is one consisting of fifteen lines at the beginning of the first chapter. There is no illustration of the instrument accompanying it, and it is, and any other description would be, unintelligible to a beginner without an engraving of some kind. The understandableness—to coin a word—of any description, too, will depend very much upon the fulness and clearness of the engraving of it. In this respect the author has certainly been lacking in "constructive imagination."

In explaining the practical application of the indicator he describes, among other appliances, the pantograph; but he would be a very bright person indeed who, without any other knowledge, could comprehend from the meagre description and the illustration how this is applied to the indicator, and what it is intended to do when it is so applied. There is no clear description, either, of the action of the steam in the cylinder, which a beginner could easily understand, nor an explanation of how the indicator shows this action. Of observations relating to its actual use the book is full. Thus, after the brief description referred to, without a break even into separate paragraphs, the reader is told, "Before using the indicator, clean the bearing surfaces of the cylinder and piston, and lubricate them with the best cylinder oil that is clean and does not stick or gum," which is important and useful instruction, but it cannot take the place of some clear comprehension of what an indicator is and is intended for. The book is full of information with reference to what may be called the manipulation of the indicator, which is excellent in its way, but it leaves the reader in a fog about the principles of the subjects which are being explained. Thus, on page 39 it is said: "The amount of cushion per square inch on the piston depends principally on the weight of these parts and the speed of the engine; and no more cushion should be given than is required to accomplish this result, as a greater amount has the same defect as too early admission." Now, after reading this, almost any intelligent person would have an insatiable desire to ask *how much* cushion "is required," which is not explained.

Chapter IV is on Diagram Analysis; V, on Cushion; VI, on Setting Corliss Valves with the Indicator; VII, on Diagram from Steam Pipe; VIII, on Setting Automatic Riding Cut-off Valves with the Indicator; IX, on Setting Single Valve Automatics with the Indicator. Succeeding chapters are on Boiler Feed Pump Diagrams; Calculating the Mean Effective Pressure by Ordinates; The Planimeter; Computing the I.H.P. of an Engine; Testing the Piston and Valve for Leaks; Locating the Theoretical Curve; Steam Tables and an Analysis of Diagram from an Ammonia Compressor.

All these chapters are brimful of practical suggestions, the residuum, as it were, of the experience of the writer, and which will be very profitable reading to any one seeking information on this subject. In another respect, too, the book may be highly commended—that is, by the absence of mathematical gymnastics. The author has given the results of his observation and experience in a very plain, matter-of-fact way. He gives in great fulness examples of indicator cards which "indicate" various defects and organic diseases, and tells the reader how to make his diagnosis and what remedy to apply. The author has not attempted to show how much mathematical knowledge he was the proud possessor of, for which credit is due to him. It is true that he now and then has a fling at "so-called" experts, which is suggestive; but his book tells us very clearly and simply what he has evidently learned by observation and has been confirmed by experience.

BOOKS RECEIVED.

TRANSACTIONS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Vol. XV. 1,359 pp., 6 × 9 in.

POPULAR SCIENTIFIC LECTURES. By Ernest Meech. Chicago: The Open Court Publishing Company. 313 pp., 5 × 7½ in.

EIGHTH ANNUAL REPORT OF THE INTERSTATE COMMERCE COMMISSION. Washington: Government Printing Office. 271 pp., 5¾ × 9 in.

PROCEEDINGS OF THE U. S. NAVAL INSTITUTE. Vol. XX. No. 4. Published quarterly by the Institute, Annapolis, Md. 206 pp., 5¾ × 9¼ in.

STREET RAILWAY INVESTMENTS. A Study in Values. By Edward E. Higgins. New York: Street Railway Publishing Company. 102 pp., 5¾ × 9 in.

JOURNAL OF THE AMERICAN SOCIETY OF NAVAL ENGINEERS. Vol. VII, No. 1, Feburary, 1895. Published quarterly by the Society, Washington, D. C. 214 pp., 5¾ × 9¼ in.

ADMINISTRATION REPORT ON THE RAILWAYS IN INDIA FOR 1893–94. By Lieutenant-Colonel T. Gracey, R.E., Officiating Director-General of Railways, Calcutta. India: Office of the Superintendent of Government Printing. 453 pp., 8¼ × 13 in., with map of Indian railways.

TRADE CATALOGUES.

IN 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. The advantages of conforming to these sizes have been recognized, not only by railroad men, but outside of railroad circles, and many engineers make a practice of immediately consigning to the waste-basket all catalogues that do not come within a very narrow margin of these standard sizes. They are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

STANDARDS:

For postal-card circulars............	3¾ in. × 6½ in.
Pamphlets and trade catalogues.......	3½ in. × 6 in. 6 in. × 9 in. 9 in. × 12 in.
Specifications and letter paper........	8½ in. × 10¾ in.

MARKS' PATENT ARTIFICIAL LIMBS WITH RUBBER HANDS AND FEET. A. A. Marks, New York. 33 pp., 3¾ × 8¾ in.

This is not a cheerful publication to review. It is all about artificial limbs, amputations, etc., and all that need be said is that those unfortunates who need the information which it is intended to give can obtain a copy from the publisher, whose address is 701 Broadway.

THE LODGE & SHIPLEY MACHINE TOOL COMPANY. Machine Tools for the Rapid Production of Lathe Work. Cincinnati, O. 24 pp., 3⅜ × 6¼ in.

A very good wood-engraving of one of this company's lathes forms the frontispiece of this catalogue and is the type of a number of different sizes which are fully described in the rest of the pamphlet.

LUKENS IRON & STEEL COMPANY, Coatesville, Pa. 62 pp., 4¼ × 7 in.

The Lukens Company make boiler plates, and incidentally thereto they also flange boiler heads and flue and manholes, supply manhole covers of a design of their own, and also make the Huston boiler brace, which is formed out of strips of steel, bent so as to form the feet and increase the strength of the brace itself. A number of tables and a telegraphic code completes the book.

BRASS PIPE FOR PLUMBING. By the American Tube Works, Boston. 68 pp., 3¾ × 5¾ in.

The purpose of this pamphlet is to describe the pipe made by this company and point out its uses and advantages. Certificates from plumbers and others are given, showing the superiority of this kind of tubing so attractively that after looking through it one is inclined to rip out all the old pipes in his house and put in new ones—a result which, no doubt, the American Tube Works would like to have accomplished.

THE DAYTON RAILWAY CROSSING GATE, for the Protection of Street Crossings. Manufactured by the Craig-Reynolds Foundry Company, Dayton, O. 20 pp., 5 × 6¾ in.

Some six months or more ago this company issued a catalogue which was noticed in our issue of last June. We then poked a little fun at the company on account of some poetry which was published in their catalogue. In the edition before us the effusion which was the occasion of our pleasantry is omitted. The gates which the company makes are very well illustrated and clearly described, although we wonder why the engravings were not made so as to occupy more of the pages on which they are printed. If made to a larger scale they would have been much more effective than they now are. The frontispiece is a good view of the works from a wash drawing,

and the "finis" is an admirable little engraving representing an angel in conjunction with a Dayton railway gate protecting a crossing.

THE PNEUMATIC POWER AND MOTOR COMPANY, OF NEW YORK. 18 pp., 6 × 9 in.

This pamphlet is the prospectus of a scheme for using "pneumatic" power for propelling vehicles on "steam, street, or elevated railroads." What is proposed is the use of a tube, or, rather, a continuous cylinder laid in a conduit between and below the rails. In this a piston or pistons move which are to be connected by some kind of attachment or "grip" to the vehicles, and is similar to that which was tried on a road in Ireland between Kingstown and Dalkey in the forties, and which is illustrated and described in the early books on railroads. The authors give us very little description of their proposed system, but elaborate calculations of its economy. Whether compressed air is to be forced into the cylinders or the air exhausted from them we cannot find out from the pamphlet before us. At a very prominent place, though, it is said that "the capital stock is divided into 500,000 shares of the par value of $10 each, full paid and non-assessable." Readers who don't want to miss the chance of subscribing had better hasten to the office of the company, which is at 55 Dey Street, New York.

ILLUSTRATED CATALOGUE AND PRICE-LIST OF PUMPS AND HYDRAULIC MACHINERY FOR EVERY SERVICE. Pump, Supplies, Well Tools, etc. Manufactured by the Goulds Manufacturing Company, Seneca Falls, N. Y. 356 pp., 7 × 8 in.

The Goulds Manufacturing Company make pumps for domestic, industrial, and manufacturing purposes, and in the catalogue before us only hand pumps and those operated by power, belting, gearing or electricity are described. No steam pumps—that is, those in which the steam pressure in a steam cylinder is applied directly through a piston-rod to a hydraulic cylinder, are shown. As some hundreds of different kinds of pumps are illustrated, obviously only a passing reference can be made to the classes in which they are included. These include pumps for domestic purposes, irrigation, centrifugal, and power pumps of various kinds; boiler feed pumps, spray pumps, garden and fire engines, hydraulic rams and hydrants, and a miscellaneous assortment of supplies, such as pipes, cocks, pipe fittings, etc.

In going through the book and seeing the great variety and extent of the business of pump-making, one is impressed with the idea that if the Goulds Manufacturing Company had existed in Noah's time that the deluge might not have happened, as this company could perhaps have pumped it dry.

The mechanical execution of the book is excellent, and besides the mere matter pertaining to a catalogue there is considerable information scattered through it of a technical nature relating to pumps and hydraulic machinery. A good index at the front adds to a reader's confidence in the pages which follow.

CONCERNING MANNING BOILERS, with a Report upon the Performance of the Bigelow-Manning Boilers at the Bristol Manufacturing Company's Cotton Mills in New Bedford, Mass., made by J. E. Denton, Professor of Experimental Mechanics, Stevens Institute of Technology. The Bigelow Company, New Haven, Conn. 34 pp., 5¾ × 9 in.

The descriptive title of this pamphlet indicates its general purpose, which is to describe the Manning boiler and set forth its advantages. This is very well done, first by a description and next by some admirable wood-engravings, one showing a front view of a boiler partly in section, another a sectional plan and a section of the ash-pit. Other outline views show a plan front and end views of a battery of eight boilers of the Bristol Manufacturing Company, and also a perspective view of these boilers as they appear in the boiler-room made from a wash drawing. Professor Denton's report is full and complete and gives all the data likely to be looked for in such an investigation.

The Manning boiler is vertical and internally fired, with a cylindrical fire-box surrounded with water spaces. The fire box is of larger diameter than the barrel of the boiler, the latter being attached to the outer shell of the former by a double-flanged plate which permits of a limited amount of difference of expansion between the tubes and the shell. The upper ends of the tubes pass through the steam space for some distance, the effect of which is to superheat the steam somewhat. This form of boiler seems to be gaining in favor wherever used.

A CATALOGUE OF THE DEVICES AND THEIR PARTS MANUFACTURED BY THE UNION SWITCH & SIGNAL COMPANY, Swissvale, Pa. 351 pp., 9 × 12 in.

The magnificent volume before us, which has just been issued by the Union Switch & Signal Company, is essentially a catalogue, and only to a very limited extent a treatise descriptive of the science and art of signalling. Under separate heads it treats of the Saxby & Farmer Improved Interlocking Machine; the Electro-Pneumatic Interlocking Machine; Electro-Pneumatic Automatic Block Signalling; the Union Electric Banner, Target and Disk Signals, and the "Union" Lock and Block System.

Most of the illustrations in the book are half-tone engravings made from photographs. A general view is usually given of the mechanism illustrated, and the separate details of the various parts are then represented. These were assembled or grouped, and each group occupies a page, or, in some cases, a part of a page, which is designated by a "plate" number. The plate and piece number being given thus indicates precisely what is referred to. Accompanying the different plates is a list of the parts represented, giving their numbers, names and, in some cases, explanatory or descriptive matter in addition. Thus, plates 1 and 2 represent front and back views of the Saxby & Farmer interlocking machine, the engravings of which were made from photographs. Following this are plates 3 and 5, in which the different parts are represented separately, each being numbered. In an introduction, and at the head of each list, parties are instructed to order "by plate and number." In this way there is never any difficulty in designating exactly what is wanted.

Interspersed through the book are excellent full-page views of track and signals at different places which have been erected by the Union Switch & Signal Company. Among them are views taken at Detroit; the Grand Central Station, New York; Broad Street Station of the Pennsylvania Railroad in Philadelphia; on the Michigan Central Station, Detroit; Union Station, Chicago; five views of the Jersey City terminal of the Pennsylvania Railroad; the Newark Bay Drawbridge on the Central Railroad of New Jersey; and the train shed of the Philadelphia & Reading Railroad, in Philadelphia. Plans of most of these terminals are also given, showing the arrangement of tracks and the disposition of signals. The only criticism of these views which we find room for is that it would have been somewhat more convenient to the reader if the title of the engraving had been placed below the engraving instead of on the opposite page at right angles to the view. This observation does not, however, apply to the maps or plans of the tracks.

A table of contents at the beginning and an excellent alphabetical index at the end complete this admirable volume. The paper and typography are excellent, and the volume sent to us is luxuriously bound in flexible morocco covers with the name of the editor of this paper imprinted in becomingly modest gilt letters on the cover. The only suggestion for the improvement of this admirable catalogue which can be made is the observation that if, before the different parts were photographed, they had been painted with a dead coat of lead-colored paint the photographs and engravings would have been more effective. Without such a coat of paint not only do the defects in castings show, but they are often exaggerated, as on Plate 26, and all the local color, rust, grease stains, etc., show. All of these, excepting, perhaps, bad defects in castings, are obliterated by the paint, and the forms are brought out much more distinctly by the uniform tint of the surface.

THE PELTON WATER-WHEEL; EMBRACING IN ITS VARIATIONS OF CONSTRUCTION AND APPLICATION THE PELTON SYSTEM OF POWER. Manufactured by the Pelton Water-Wheel Company, San Francisco, Cal., and 143 Liberty Street, New York. 100 pp., 7 × 10½ in.

In an appendix to this catalogue the publishers say: "The literature pertaining to modern hydraulic methods, as embraced in the Pelton system, it is well known, is very meagre and only accessible through mining reports and trade journals, hence cannot be readily availed of by the general mining and engineering public."

Recognizing this fact, the publishers of the book before us say that they have endeavored to collect such information and present it in a form which would make it readily available by those interested in the subject. This has been very effectively done. The book begins with some general observations on the use of water-power, and then goes on to describe the construction and operation of Pelton water-wheels, of which some excellent wood-cuts and outline engravings are given. Various forms and applications of these wheels are described and illustrated. They are shown as arranged for driving dynamos,

blowers, pumps, hoists, air compressors, inclined railway at Mount Lowe, for the electric transmission of power, etc.

A great deal of information is given with reference to estimates for water power, size, capacity and weight of wheels, H.P. of water. A very interesting portion is that relating to the use of wrought-iron riveted hydraulic pipe, which has been used so extensively and successfully on the Pacific Coast for conducting water from its sources of supply to places where its power was to be utilized. Elaborate tables giving the price, weight, loss of head in pipe from friction, etc., are given. Much other information of very great interest to all concerned in this method of generating power is contained in this interesting book, but to which there is not room to refer. It is, however, deserving of the highest commendation in every respect. Printing, paper, engraving, and typography are all excellent.

Illustrated Catalogue and General Description of Improved Machine Tools for Working Metal. Designed and Constructed by William Sellers & Co., Incorporated. Philadelphia. 429 pp., 7¼ × 7¼ in.

We are acquainted with a reflective person who, at times, when the complexity of modern life forces itself upon his attention, makes the observation that if, through any great cataclysm of nature, we should be buried as ancient Herculaneum and Pompeii were, and if some thousands of years thereafter our remains should be dug up, "what a d——l of a time the archæologists will have to tell what all the appliances of the present day were intended for." Doubtless our friend would repeat his observation if he should go through the new catalogue which has just been issued by William Sellers & Co. It is illustrated by 243 engravings, showing a variety of machinery for working and handling metal, a list of which would exceed the limits which we can here give to it, and its variety and intricacy would deter even an expert in this branch of mechanical engineering from attempting to understand the purposes, uses, and adaptations of all the machines which are illustrated therein unless a liberal amount of time was allowed him for the task. If in the year 4995 a copy of this book should be dug up from under the ruins of, say, the City Hall of Philadelphia, the archæological society of the "coming race" will doubtless hold special meetings and listen to tedious papers—as we do now—to show what the appliances which are illustrated therein were intended for; and when they learn further what that hall cost, and read of the corruption of the ruling classes in our cities of to-day, they may conclude that the ponderous shearing machines illustrated on pages 226 and 227 were intended to behead politicians, and the travelling cranes for hanging them by wholesale, and the steam hammers for crushing them expeditiously out of existence, and thus reducing them to a condition which would be without form and void. This analogy might be carried still farther, but it would only lead to the reflection that we can now see no reason why our descendants should need any better machine tools than William Sellers & Co. make, and to entertaining the hope that in a few thousand years they will have improved on our political methods and practices.

As the book is somewhat novel in its form and design, and the engravings were made by a method not generally adopted, a little description, which is quoted from a letter received from the compiler of the book, will be of interest:

"As the proposed book," he says, "was not to be made for sale or to ornament the shelves of a library, but for purely business purposes, to be handed about and perhaps studied by two or more persons at the same time, two radical departures from usual custom were proposed and adopted; one related to the shape of the book, whereby all the illustrations of horizontal and upright tools appear in the same position as the type matter. The other point of departure was to have the plates made *as large as the page permitted.* As the book was to be a pictorial record of machines made in the past, as well as those of most recent construction, requiring more than two hundred new plates, the 'half tone' process commended itself. Samples of work were prepared by a number of bidders, but they all showed a lack of strength and sharpness of detail as compared with wood-cuts, and experiments were made to more nearly approximate the vigor of engravings or wood-cuts while retaining the photographic fidelity of the half-tone process. The method adopted was tedious and somewhat costly. A faint platinum print—usually an enlargement—was made on plain paper. This was used as a 'groundwork' for a free-hand artist, working in sepia or india ink with brush, crayon and pen. The artist's 'subject' was then examined by a mechanical draftsman, and corrections, if any were needed, were made.

"The usual half-tone negative was taken from this prepared subject, in which all of the important features had been strongly emphasized, and finally a certain amount of engraving was done upon the copper plates and the backgrounds routed out. This latter feature was quickly appreciated, and has become, since our work began two years ago, a common feature in such plates."

This method undoubtedly has the result of bringing out distinctly the details of the different machines, the vagueness of which is often a defect of half-tone work, and no doubt this method is much cheaper than wood-engraving. Photographs which are retouched in this way always have, however, more or less of exaggeration in the high lights and some details. Thus in most of the engravings in the book before us the flooring is grained "by hand," and in some of the illustrations this feature is so prominent that it strikes one first on looking at the illustration, and it is safe to say that no lumber ever grew with such a grain as is shown in some of the illustrations. From a purely artistic point of view the illustrations can hardly be approved, but they show the machines clearly, and that is their most important purpose.

The volume opens with an introduction about machine tools generally—the design of the catalogue—and an account of the awards made to William Sellers & Co. at different exhibitions, beginning with Vienna in 1873. A number of interior views of the works are given in this introduction, and the catalogue then opens with descriptions and illustrations of bolt and nut-screwing machines, of which four different types are illustrated and described. The engravings of the machines are printed on the right-hand page and the description opposite to it. This description is fuller than is ordinarily given in similar catalogues, and sets forth the peculiar advantages of the machines illustrated, their dimensions, and often a little dissertation on the class of machines described.

Under the head of Vertical Drill Presses seven types are shown and described. Eight other special drilling machines, including radial drills, are also illustrated. Thirty different types of boring machines, horizontal and vertical, are included under that head, and 25 different kinds of lathes in the following one. There is a strong temptation to quote the dissertation on lathes with which this section is prefaced. Generally it is an argument for the flat-top shear instead of the V shear.

Seven different examples of grinding machinery and a large number of examples of lathe, planer and miscellaneous tools, which have been finished on the tool-grinding machine, are illustrated. A cold saw for cutting rails, beams, etc., is also represented. This is followed by milling machines, of which six varieties are given. The following list of the additional machines illustrated will give an idea of the variety of the tools which are made by this company: Two rotary planers; 5 shaping machines; 4 slotters; 16 planing machines; 1 rifling machine; 20 punching and shearing machines; 6 steam hammers; 11 riveting machines, steam and hydraulic; a hydraulic accumulator and pump; straightening machines for shafts and beams; 11 plate-bending rolls; 7 hydraulic presses and screw machines; 4 hoisting machines; 13 jib cranes; 14 travelling cranes; a sand-mixing machine; 9 illustrations of turn-tables; 10 illustrations of "Emery" testing machines; 11 illustrations and a long article on shafting, with a considerable essay on that subject. Under the head Injectors there are 11 illustrations. Vicar's mechanical stoker is also illustrated and described. An excellent index, in which the reference words are printed in black-faced type, completes this admirable publication.

PHYSICAL REASONS FOR RAPID CORROSION OF STEEL BOILER TUBES.

In investigating the oft-repeated assertion that "boiler tubes made from steel corrode and become unserviceable much more rapidly than those made from charcoal iron," we have made the following experiments, as given below:

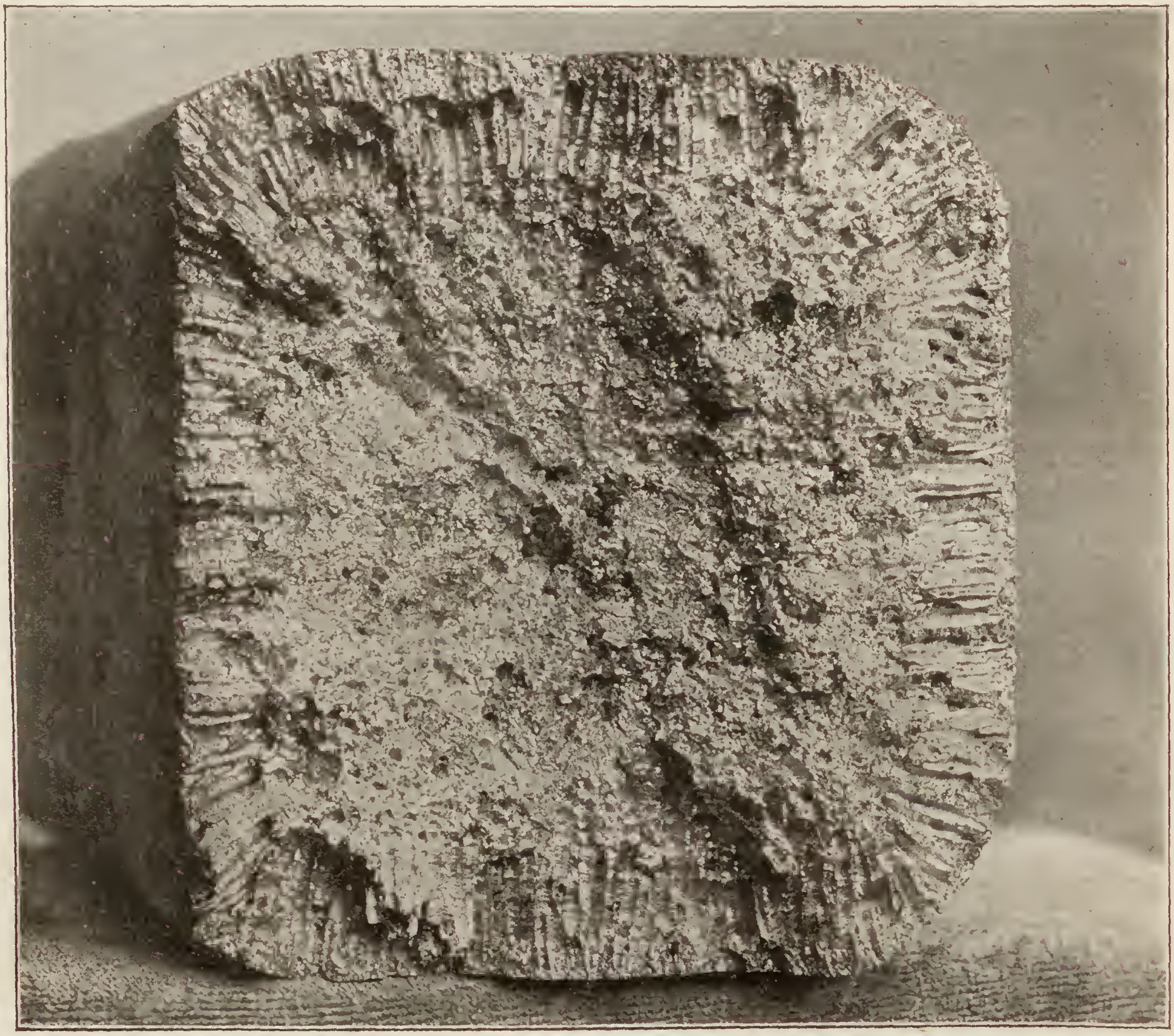
Taking a "heat" of ingots made of 7 in. × 7 in. × 4 in., weighing about 650 lbs. each, of the best open-hearth basic steel of following analysis: Carbon, .10; phosphorus, .014; manganese, .21; sulphur, .026; copper, .05, we first gave them a "wash heat" and cut them into two nearly equal pieces, then transferred them to heating furnaces again, and after another slight heating rolled them down direct to No. 9 gauge and sheared them into skelp for 4-in. tubes, being careful to keep separate the skelp made from tops and bottoms of ingots.

We found that the "bottoms" of the ingots invariably worked smooth and clean into plates and sheared with only a normal wastage, but that the "tops" were almost uncontrollable in rolling, working soft, spongy, and with much irregu-

larity, and the surface of the plates when finished had a muddy, dirty appearance, indicating an excessive amount of cinder. Allowing one of the "tops" of ingots to cool after the first wash heat, on close examination its whole surface was found to be closely covered with minute holes, so close together that in a diameter of 1 in. as many as 25 of these minute holes could be counted, into which in many instances a needle could be entered to the depth of from 1 in. to 1½ in.

creased in size, but still present in great numbers in the "top" section, while the "bottom" was comparatively smooth and solid.

Each one of these compressed cells has walls of solid metal encasing infinitesimal shot of slag, which in the boiler tube in service, with the incessant expansion and contraction of greater or less heat, will finally open slightly, admitting a little dampness, which under the heated condition of action



FRACTURE OF OPEN-HEARTH STEEL INGOT. AREA, 6½ IN. × 6½ IN.

Number of Cells immediately under Surface exposed in Fracture, 253. Average Depth of Cell, 1⅛ in. Average Diameter of Cell, ⅛ in. Analysis: Carbon, .10; Phosphorus, .014; Manganese, .21; Sulphur, .026; Copper, .05. A Physical Reason for the Corrosion of Steel Boiler Tubes.

will undoubtedly set up very rapid corrosion and early disintegration of the whole tube.

Our next step was to nick and break with a heavy drop the upper or "top" of one of these ingots before heating, with the result that the fracture developed an almost entirely spongy or honeycombed structure, extending from ½ in. under the skin or surface to about 1½ in. in depth uniformly around the four sides of the ingot, and in many instances these cells ramified and extended to the centre. Actual count of these cells in face of fracture 6½ in. × 6½ in. was 253.

This spongy condition, no doubt, revealed the at first unaccounted-for difference in working between "top" and "bottom," as the same ingot when broken cold, half-way up, showed much less of the cellular structure, which, no doubt, almost entirely disappeared on a nearer approach to the bottom, owing to hydrostatic pressure of molten steel in the mould driving out the gases before solidification occurred.

Our next step was to have tubes made from "tops" and "bottoms," with a report as to the working of the two, which only went to confirm our earlier investigations, that the "tops" welded freely, and even blistered sometimes, while the "bottoms" worked hard and stubborn and were difficult to weld. Taking sections of these tubes made from the respective portions of ingot, they were put in a lathe, burnished, and subjected to microscopical examination, which revealed these same "cells" or "honeycomb" structures much de-

Before we had the opportunity of making this thorough test we were at a loss to know why steel tubes made from finest obtainable open-hearth stock should show such short lives when compared with those made from *charcoal iron*, but this would seem to be ample confirmation, for the known fact that, as a rule, steel has been most disappointing in service when compared with the possibly less pure chemically, but more homogeneous and durable charcoal iron.

To make a free welding steel for boiler tubes, this sponginess *must* exist, and the more pronounced it is, the more thoroughly it will weld and the more rapidly it will corrode. Conversely, the more solid and free it is from "honeycomb" in the ingot, the more difficult, if not impossible, it is to weld, and the longer the *unwelded* life in the boiler.

It is a matter of record that the United States cruiser *Chicago* put new steel tubes into some of her boilers about two years ago, that were riddled with holes as large as shot inside of 40 days' service, while others of her boilers had the original charcoal iron tubes that were put in when they were built, and which were still good after service of some five years.

PARKESBURG IRON CO.,

Parkesburg, Pa. W. H. GIBBONS, *President.*

SOME FACTS RELATING TO CERTAIN TYPES OF WATER-TUBE BOILERS.*

In buying a boiler, it is just as necessary to know what *won't* do as what *will* do.

A certain set of elementary forms or units have been repeatedly used in the construction of sectional and water-tube boilers, and have by repeated failures demonstrated their unfitness for the service required.

The primary cause of their failure can be traced, in every instance, to the impossibility of removing the accumulation of scale that must result from the evaporation of water (despite the claims made by the inventors that the rapidity of the circulation in their particular design prevents the deposit of scale) ; and until some inventor succeeds in evaporating salts of lime into steam, failures of these particular forms must be expected.

Re-inventing a device, or disposing of a well-known unit in a slightly different position, retaining all its elementary defects, cannot alter the final results. Boilers come within the Darwinian law of "*the survival of the fittest*," as surely as does any form of animal life, and the reappearance of unsuccessful forms must be regarded as a freak, not of nature, but of inventors. It is time that some of these unsuccessful elements should be specified, and as it would be impossible to chronicle all the deaths and resurrections that have occurred among these unfortunate families, we have selected typical cases, emphasized by the prominence they have attained at their first appearance, or subsequent prominence in engineering circles, due to their repeated failures.

UNIT NO. 1.

Closed-End Tube.

RADIAL WATER TUBES WITH ONE END CLOSED, THE OTHER END HAVING FREE CONNECTION WITH A WATER RESERVOIR.

John Cox Stevens, an American engineer, was the first inventor of this unit, using it in the boiler (fig. 1) of a small

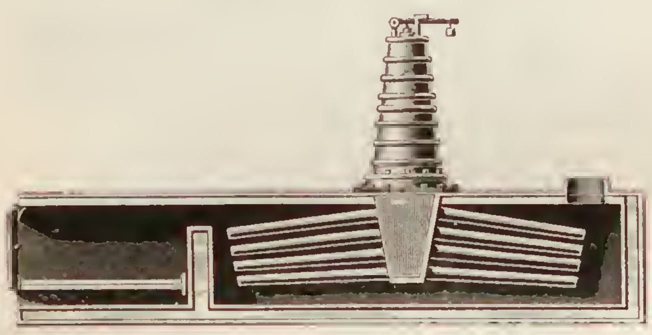


Fig. 1.—JOHN COX STEVENS, 1805.
Transactions of American Society Mechanical Engineers, Vol. VI., p. 601.

steamboat on the Hudson River in 1805. It consisted of a vertical steam and water reservoir, the lower portion of which projected downward into a fire-box. The main heating surface was made up of closed ended tubes radiating from the fire box section at a slight inclination from the horizontal.

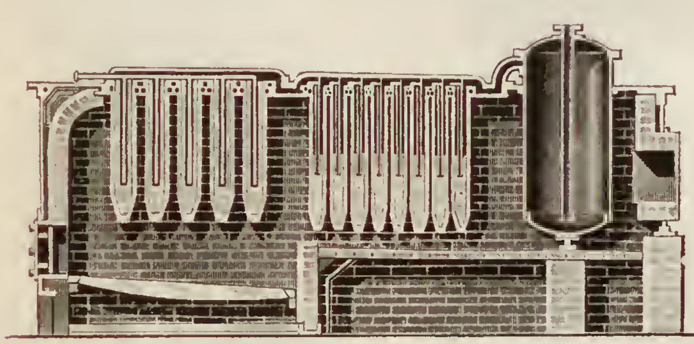


Fig. 2.—THE JOLY BOILER, 1857.
Burgh on Boilers, p. 166.

Mr. Joly first used this unit in the construction of a *sectional* boiler (fig. 2) in 1857, feeding each vertical drop tube with a separate internal pipe, extending nearly to the bottom.

Merryweather brought out a vertical fire-box boiler (fig. 3) in 1862, using drop tubes hanging vertically from the crown-

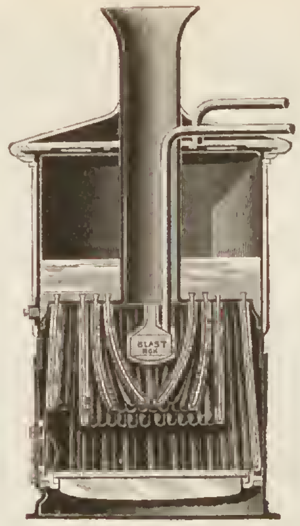


Fig. 3.—THE MERRYWEATHER BOILER, 1862.
British Patent, 1862.

sheet, and adding inside circulation tubes. This was used principally for fire-engine purposes, and as rapidity of steaming was the main requirement. lasting qualities and economy being secondary, it met with fair success for its special work.

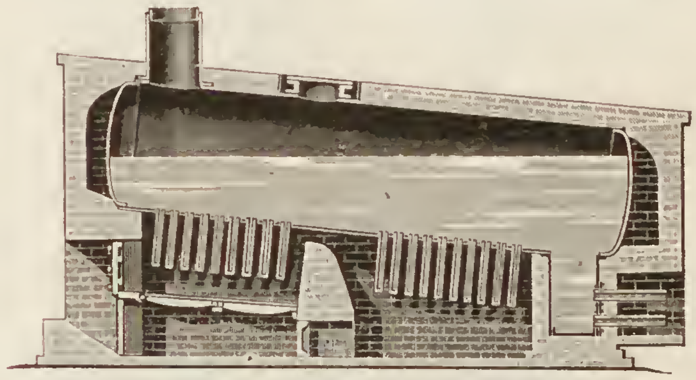


Fig. 4.—THE FIELD BOILER, 1866.
Burgh on Boilers, p. 142.

Field used a cylinder boiler (fig. 4) slightly inclined from the horizontal, with radiating drop tubes fitted to the lower side.

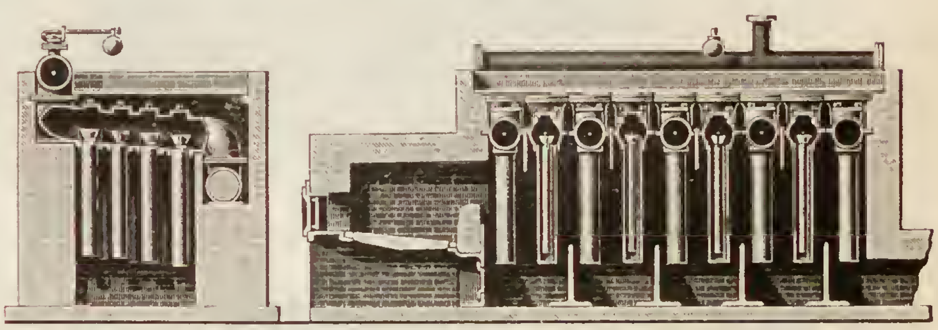


Fig. 5.—THE FIELD BOILER, 1867.
Transactions Society of Engineers. Pendred's Paper on Water-Tube Boilers, 1867.

Field also re-invented, with slight changes, the Joly boiler of 1857, and adopted Merryweather's inside circulating tubes.

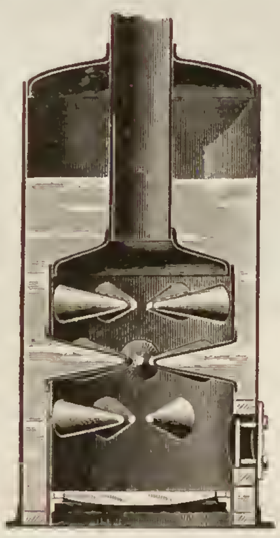


Fig. 6.—THE FLETCHER BOILER, 1869.
Burgh on Boilers, p. 85.

Fletcher used a vertical fire-box boiler (fig. 6) with horizontal cone-shaped tubes radiating from the sides of the fire-box toward the centre. This is probably the least objectionable form of the closed-end tube.

* From advance sheets of a publication by the Babcock & Wilcox Company.

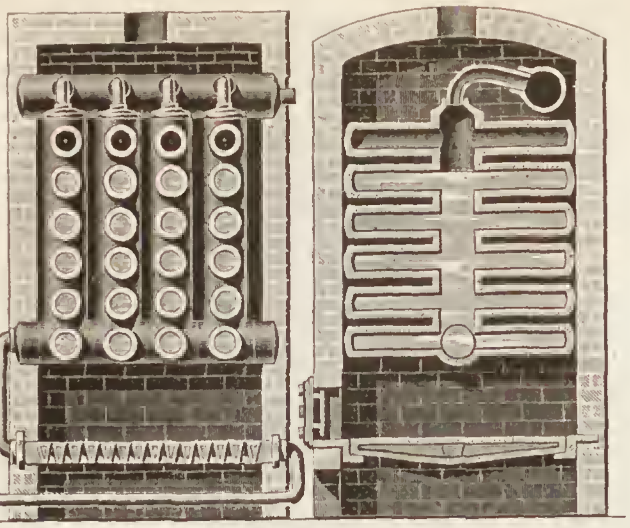


Fig. 7.—THE B. T. BABBITT BOILER, 1869.
Trade Circular Issued in New York.

B. T. Babbitt, of New York, used a cast-iron construction of vertical tubes (fig. 7) connected together, top and bottom, each vertical tube having horizontal radial tubes on each side, thoroughly demonstrating the folly of placing a combination of thick cast metal and scale between fire and water.

J. A. Miller used cast headers, to which were fixed closed ended tubes with an inner circulating tube (fig. 8). These

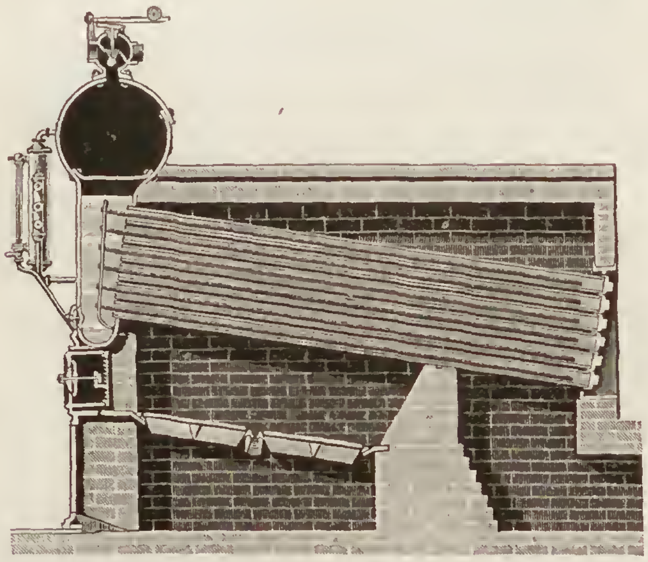


Fig. 8.—THE MILLER BOILER, 1870.
U. S. Patent No. 106,388.

stood at an angle of about 15° from the horizontal, and were of such length as to allow of two passages of the gases across them.

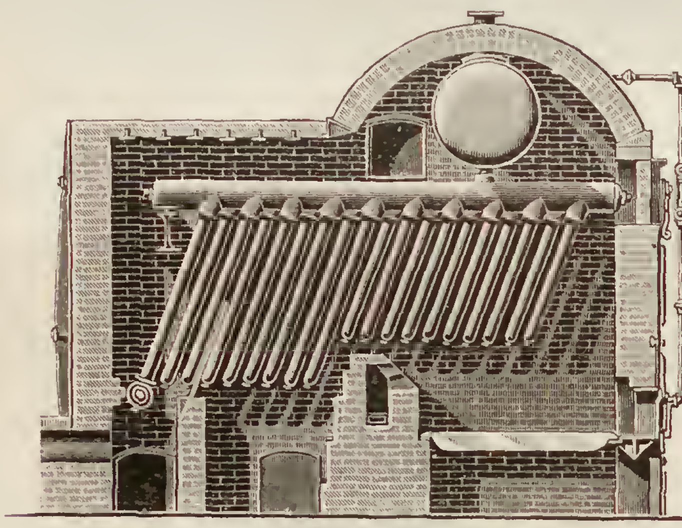


Fig. 9.—THE ALLEN BOILER, 1871.
Report of American Institute Fair Tests, 1871.

Allen nearly duplicated Joly of 1857 and Field of 1866, using cast-iron drop tubes (screwed into a horizontal tube at the top), slightly inclined from the vertical (fig. 9).

Wiegand connected groups of vertical tubes, having inside circulating tubes, to an overhead steam and water reservoir (fig. 10). Caps were screwed on the bottom of the tubes for cleaning(?), but they generally came off without the assistance of a wrench.

Plambeck & Darkin modified Fletcher's design of 1869, substituting cylindrical for conical tubes and making his outer shell removable (fig. 11). This being taken off, the tubes could be bored out.

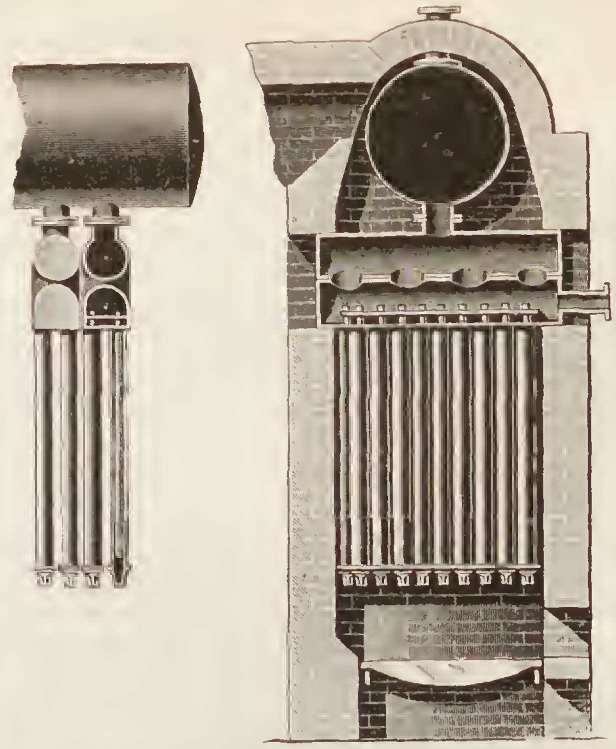


Fig. 10.—THE WIEGAND BOILER, 1872.
Judges' Report, Centennial Exhibition, 1876.

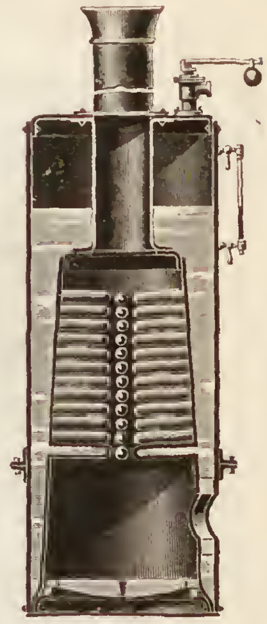


Fig. 11.
THE PLAMBECK & DARKIN BOILER.
Trade Circular, about 1874.

W. E. Kelley, of New Brunswick, N. J., adopted J. A. Miller's design of 1870, adding a drum or so and a subterra-

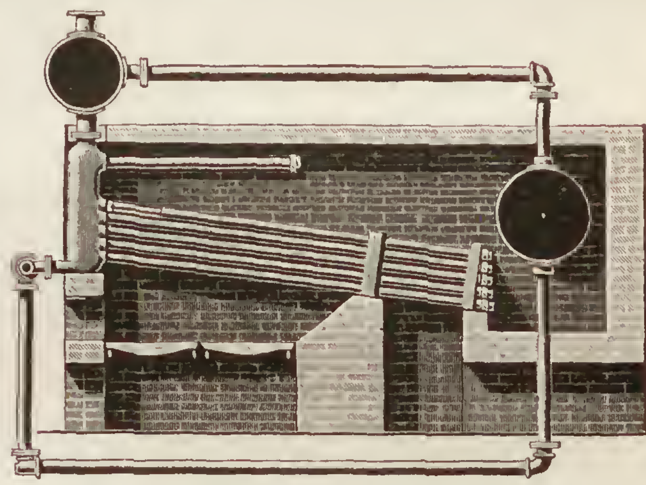


Fig. 12.—THE W. E. KELLEY BOILER, 1876.
Judges' Report, Centennial Exhibition, 1876.

nean feed and blow-off pipe (fig. 12). He was also among the first to put in superheating surface, to dry the wet steam made, due to his construction.

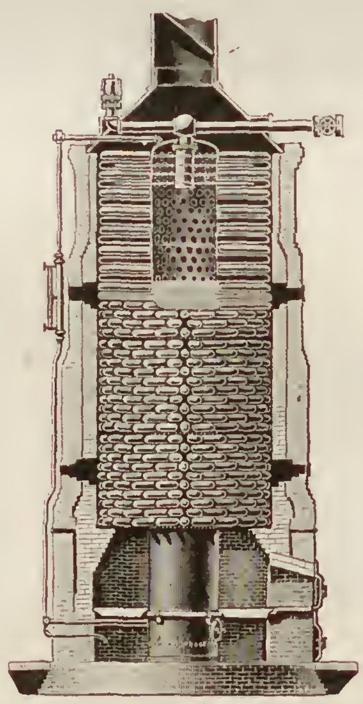


Fig. 13.—THE HAZLETON BOILER, 1881.
Trade Circular.

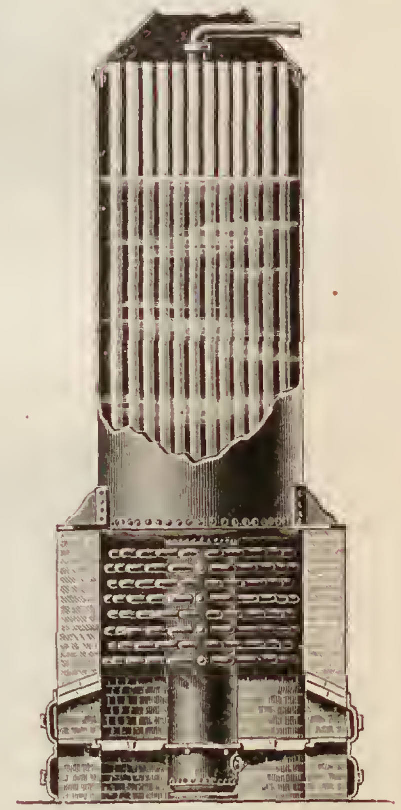


Fig. 14.—THE GEORGE H. CORLISS BOILER.
In Service about 1882.

M. Hazleton turned Plambeck & Darkin's 1874 boiler inside out, using a vertical cylinder with radial tubes (fig. 13), making wet steam and drying it afterward in the upper set of superheating tubes. This boiler has also appeared and dispeared under the names of "Adams," "Porcupine," "Minerva," and others.

Even **George H. Corliss** was seduced by this unit. He made

a boiler (fig. 14) with its lower half like a Hazleton and its upper half of his regular vertical tubular.

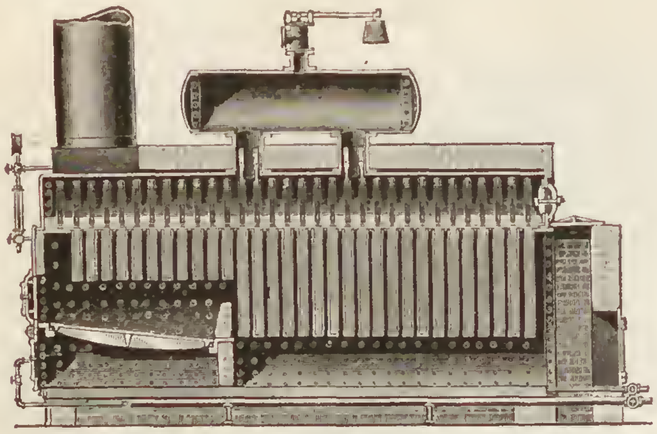


FIG. 15.—THE KINGSLEY BOILER, 1883.
From Kingsley & Hook's Trade Circular issued in Kansas City, Kan.

Kingsley brought out an internal fire-box and flue boiler (fig. 15) with stayed sides and crown-sheet, and vertical tubes dropped from the latter, being a slight modification of Marshall's British patent of 1864.

Allan Stirling exploited another form in Canada, called the Field-Stirling boiler (fig. 16), joining to the closed tube unit, bent tubes and stayed surfaces, with a wrought-metal mud-drum at the bottom, placed in the most advantageous position for both interior and exterior corrosion.

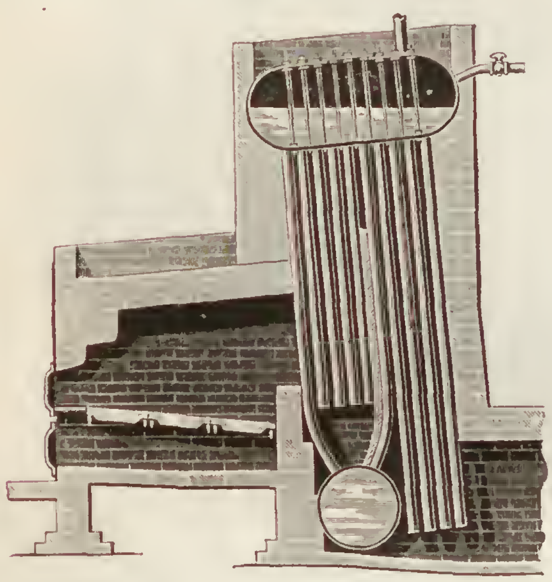


FIG. 16.—THE ALLAN STIRLING BOILER, 1887.
From Photographs issued by the Inventor.

The failure of the closed-end tube as a unit of heating surface has been accelerated by the inadequate facilities for circulation. The incoming current of water has to fight its way in against the outgoing current of steam and water, slightly modified where inner circulation tubes or diaphragms are used; and in all cases the tendency is to deposit the scale-forming material at the ends of the tubes where the current slows down, due to its change of direction, with the inevitable result of burning out.

Nearly all of the above boilers are practically out of the market.

Can any success be expected by re-inventing in any new combination this unit of a closed-ended tube?

It has been tried and failed in the following positions:

HORIZONTAL.		VERTICAL.	
By Fletcher	1869	By Joly	1857
" Babbitt	1869	" Merryweather	1867
" Plambeck & Darkin	1874	" Field	1867
" Hazleton	1881	" Wiegand	1872
" Corliss	1882	" Kingsley	1883
INCLINED FROM HORIZONTAL.		**INCLINED FROM VERTICAL.**	
By Stevens	1805	By Field	1866
" Miller	1870	" Allen	1871
" Kelley	1876	" Stirling	1887

There is only one position in which it has *not* been tried, and that is standing vertical with the closed end up.

Who will invent this for the waiting public?

UNIT NO. 2.

THE BENT TUBE, ITS ENDS CONNECTED WITH STEAM AND WATER SPACES.

This embraces all forms short of circular or box coils, the particular form given it by various inventors being simply a matter of degree. All are inaccessible for cleaning.

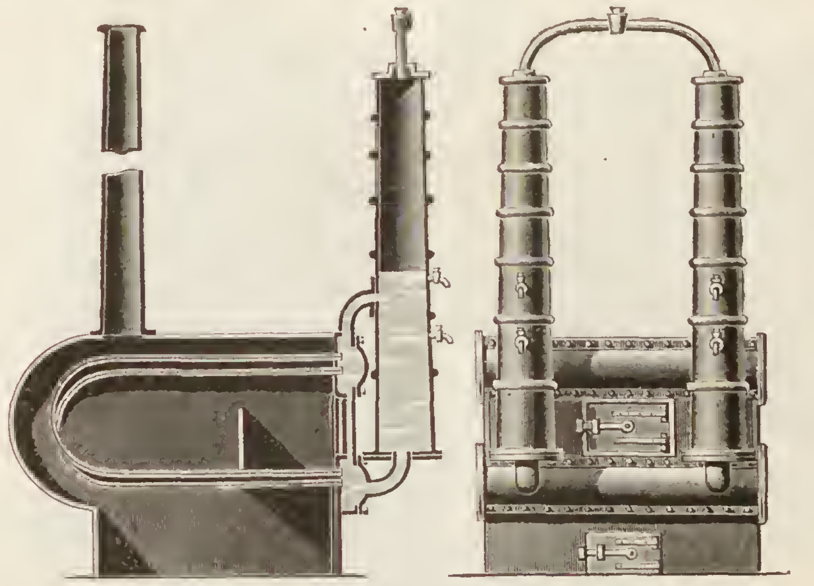


FIG. 17.—THE GOLDSWORTHY GURNEY BOILER, 1826.
Luke Hebert's Cyclopedia, London, 1828.

Goldsworthy Gurney, an English inventor, was the originator of this unit, using it in the boiler (fig. 17) of a steam road-carriage in 1826. A pair of vertical steam and water reservoirs were connected at their bottom, and about half-way up their height, by cross pipes from which a series of bent-tube units were projected into the fire-box. The tubes received their water supply at their lower end and delivered a mixed current of steam and water at about the water-line, in a continuous round of circulation. The lower row of tubes served as grates.

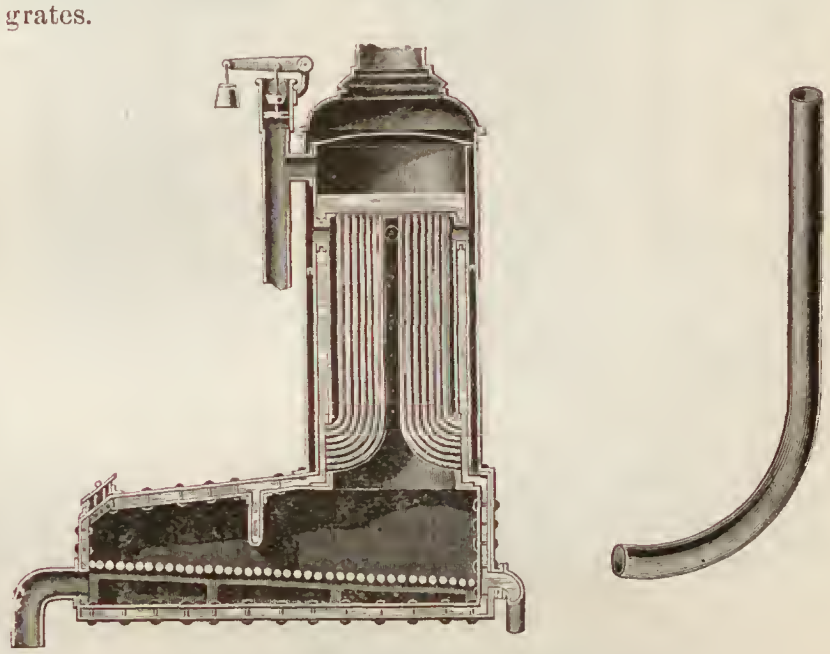


FIG. 18.—THE CHURCH BOILER, 1832.
London "Engineer," Aug. 17th, 1894.

Church built a boiler (fig. 18) for a road-carriage, with a locomotive fire-box having a vertical cylindrical extension at one end, filled with bent tubes, connecting the sides of the fire-box with the crown-sheet, and with side openings in the shape of fire-tubes extending through the shell at the top, for taking off the gases.

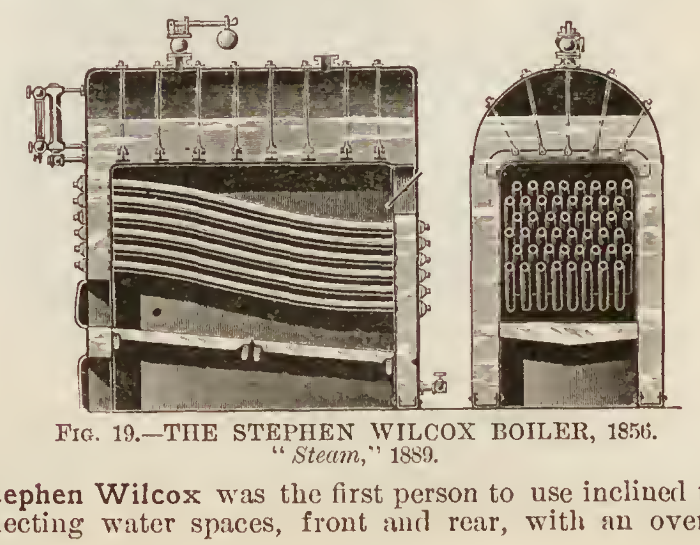


FIG. 19.—THE STEPHEN WILCOX BOILER, 1856.
"Steam," 1889.

Stephen Wilcox was the first person to use inclined tubes connecting water spaces, front and rear, with an overhead

steam and water reservoir (fig. 19). The tubes were bent at a slightly reversed curve, extending over nearly the whole length of the tube, but were inaccessible for cleaning.

Rowan introduced a boiler (fig. 20) made up of a series of units placed side by side, each unit consisting of an upper

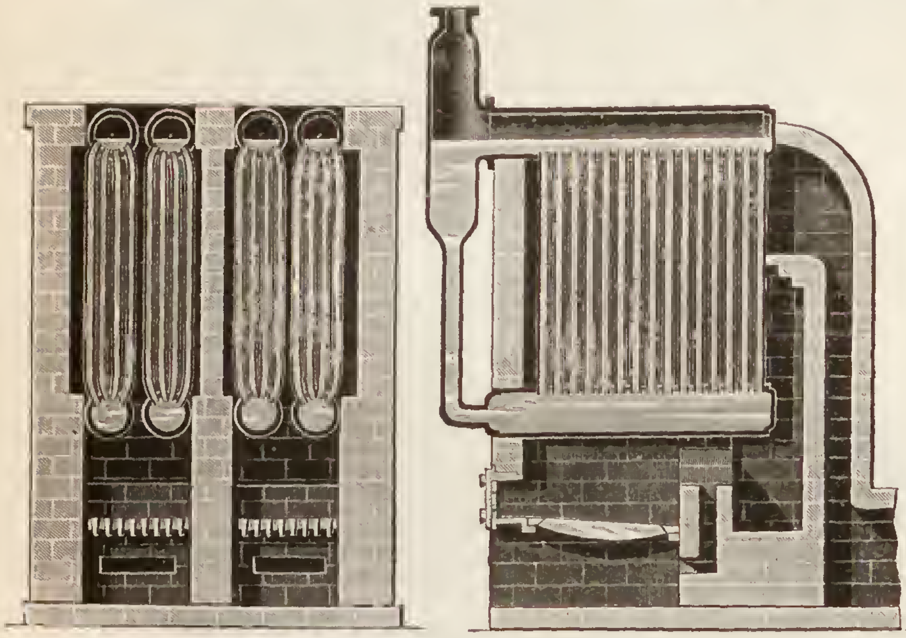


FIG. 20.—THE ROWAN BOILER, 1865.
British Patent, 1865.

and a lower horizontal drum connected by a series of bent-ended heating tubes, and at their ends outside the setting, with down-take pipes of large diameter.

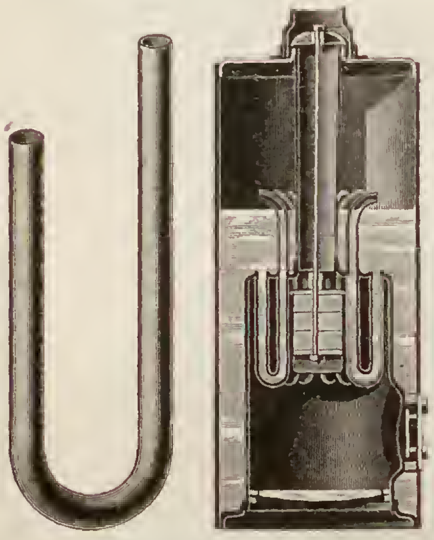


FIG. 21.—THE WILSON BOILER, 1865.
British Patent, 1865.

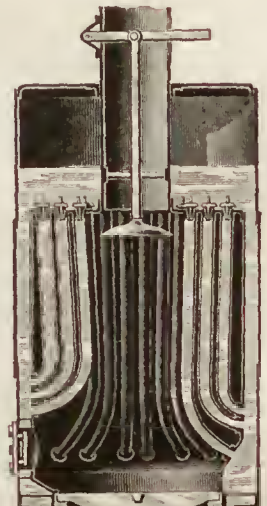


FIG. 22.—THE PAXMAN BOILER, 1870.
Burgh on Boilers, p. 94.

Wilson dropped a series of U tubes from the crown-sheet of a vertical fire-box boiler (fig. 21) one end of the U passing through and considerably above the line of the crown-sheet.

Paxman cut off the locomotive fire-box from Church's design

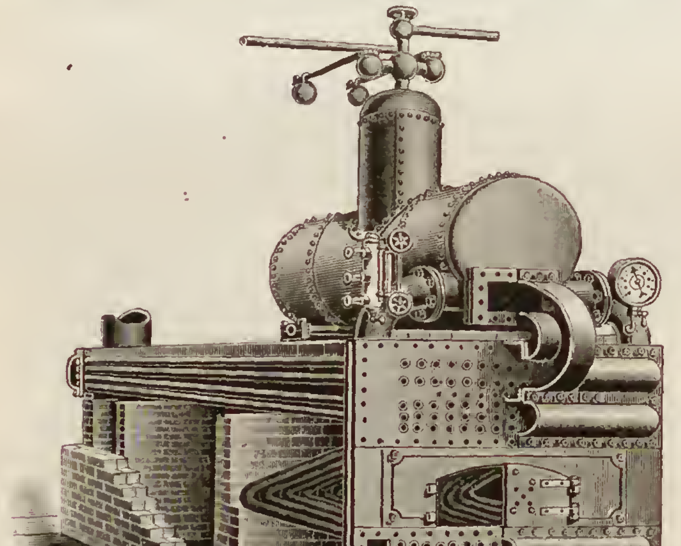


FIG. 23.—THE PHLEGER BOILER, 1871.
American Institute Exhibition Tests, 1871.

of 1832, and put in grates, leaving it a vertical cylindrical boiler (fig. 22). He placed deflectors above the ends of the tubes to prevent geyser action.

Phleger used Gurney's 1826 U tubes for fire-bars, adding a second series above for heating tubes, and, above them, a large steam and water-drum (fig. 23).

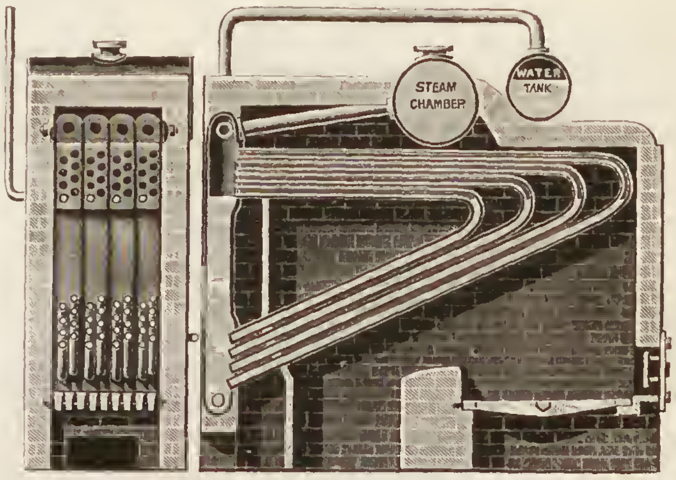


FIG. 24.—THE ALLEN BOILER, 1872.
British Patent, 1872.

Allen used Gurney's U tubes, in vertical headers connected in series, side by side, and built the fire below instead of the middle of the bank of tubes (fig. 24).

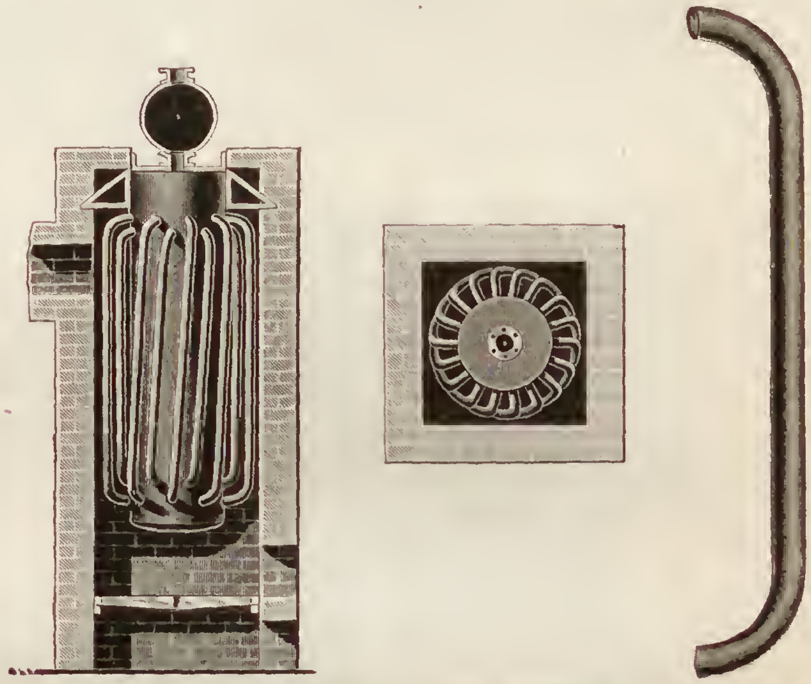


FIG. 25.—THE ROGERS & BLACK BOILER, 1876.
Judges' Report, Centennial Exhibition.

Rogers & Black placed a series of U tubes on the outside of a vertical shell, surrounded it with a brick setting and placed grates beneath it (fig. 25).

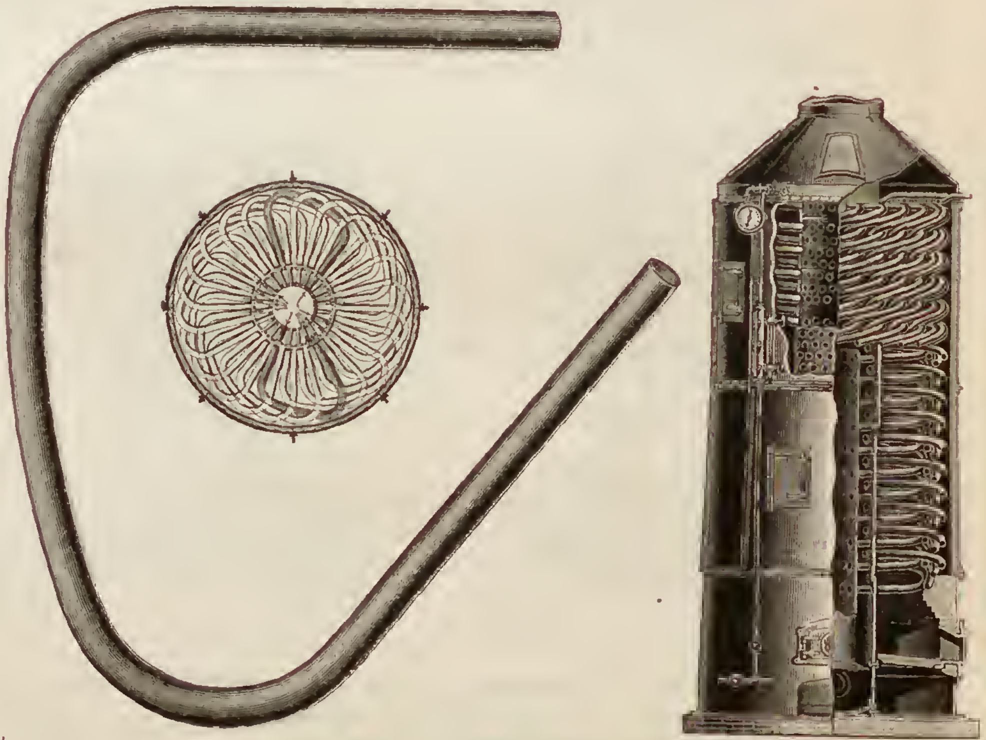


FIG. 26.—THE T. MORRIN BOILER, 1883.
U. S. Patent No. 309,727.

T. Morrin designed the "Climax" boiler (fig. 26), using a vertical cylinder punched full of holes (similar to Hazleton's 1881), expanding into them the ends of a series of crooked

loops of pipe (an exaggeration of Rogers & Black's 1876) placed at a slight inclination from the horizontal. The upper pipes were used to dry the steam made by the lower ones.

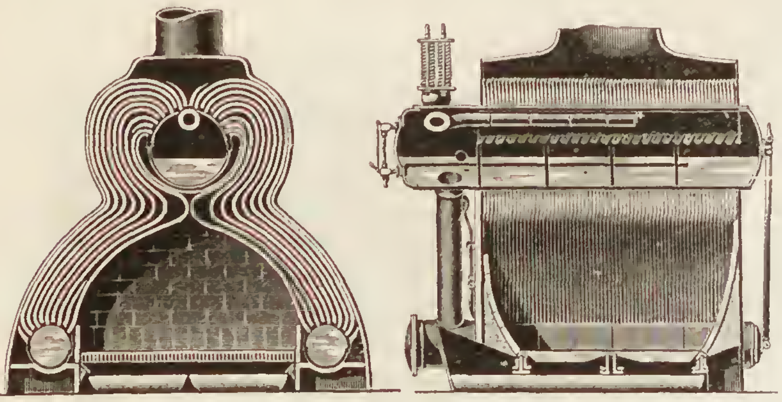


Fig. 27.—THE THORNYCROFT BOILER, 1887.
"Engineering," July 22, 1887.

Thornycroft modified Rowan's 1865 design by using two cylinders at the bottom instead of one (fig. 27), placed the grates between them and put several extra bends in the tubes

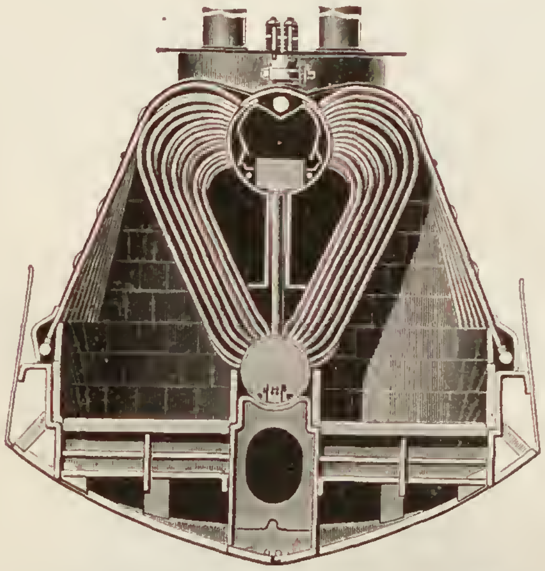


Fig. 28.—THE THORNYCROFT, 1894.
The "Daring" Type.

to increase the amount of tube surface between the points of fastening, delivering the up-current above the water-line. He retained the down-take tube, outside the furnace.

His 1894, the "Daring" type of boiler (fig. 28), reverts more nearly to Rowan's original units.

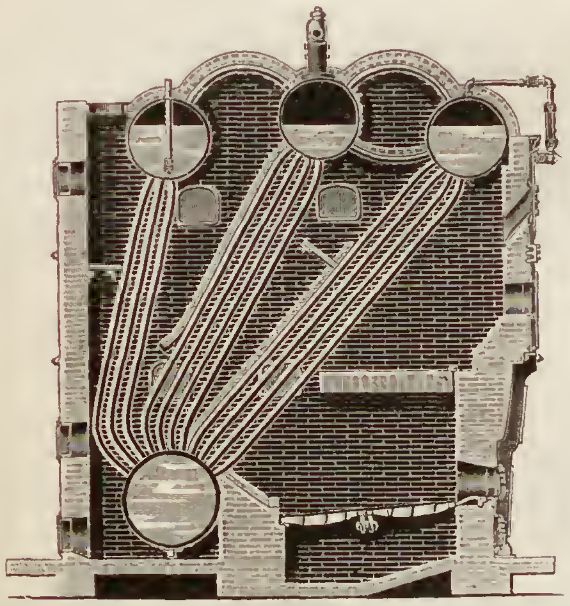


Fig. 29.—THE ALLAN STIRLING BOILER, 1888.
Trade Circular.

Allan Stirling, who used the closed-end unit in 1887, adapted the unit designed by Rowan in 1865 to a new construction (fig. 29), leaving out the opportunity for definite circulation given by the balance pipes used by the previous inventor, which secured a definite water level, retaining his original idea of a wrought-metal mud-drum exposed to exterior corrosion.

Cowles followed Thornycroft's 1887 design very closely, adding a mass of tubes at the rear of the grate. His design

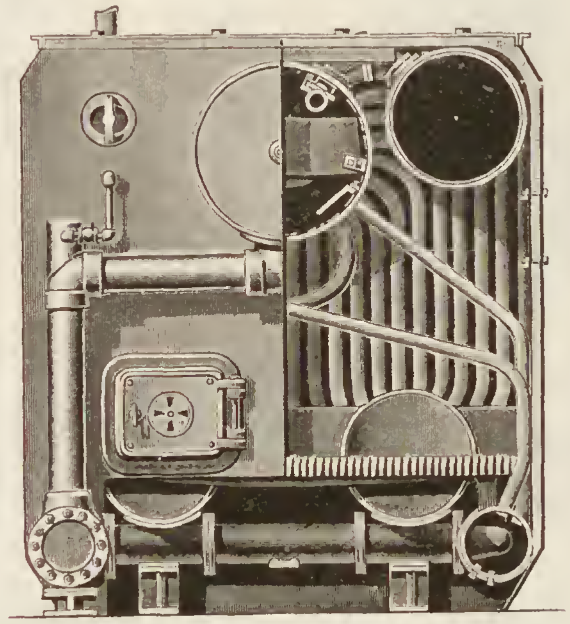


Fig. 30.—THE COWLES BOILER, 1880.
U. S. Patent No. 396,545.

(fig. 30), however, does not allow as large a proportion of grate surface to room occupied as Thornycroft's.

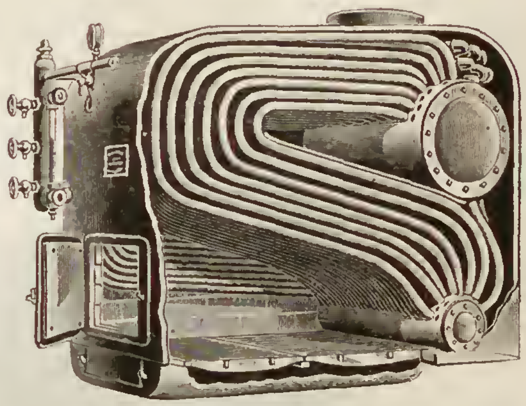


Fig. 31.—THE MOSHER SINGLE BOILER, 1890.

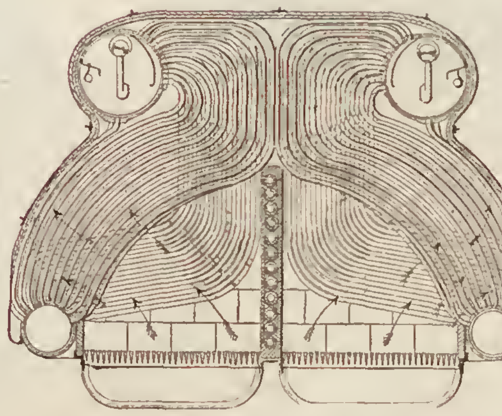


Fig. 32.—THE MOSHER DOUBLE BOILER, 1890.
Report International Engineering Congress, 1894.

Mosher used two drums placed one below the other, bent the upper ends of Thornycroft's 1887 tubes in a reverse position, and on larger sizes it was arranged Siamese-twin fashion.

Hyde either turned Paxman's 1870 design inside out, or cut off the top (fig. 33) and put a head on Rogers & Black's boiler of 1876. Mr. Smith also invented and christened it with his family name.

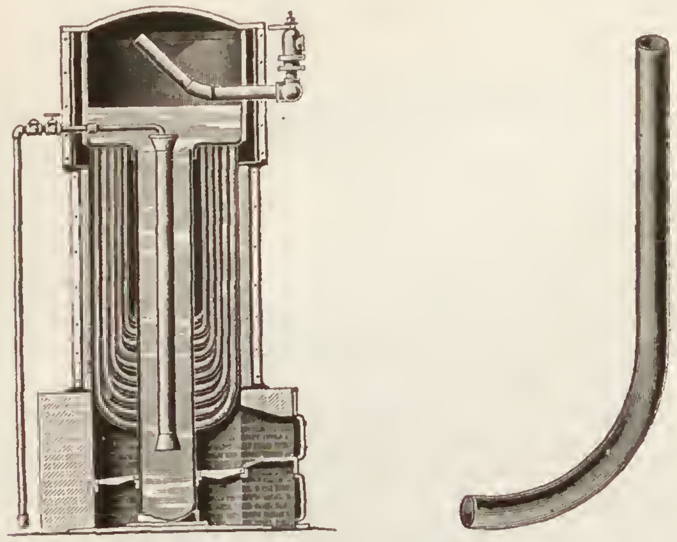


FIG. 33.—THE HYDE BOILER, 1893.
Trade Circular.

Pierpont added two more cylinders to the bottom of Stirling's design(?), and altered the name. In this boiler three wrought-metal mud-drums were exposed to exterior corrosion.

With all these examples before them persons are still trying to bend tubes into other forms, so as to "make a new boiler."

A FEW IDEAS AS TO CLEANING.

Strange to relate, the originator of this bent-pipe unit—Gurney, in 1826—recognized the necessity of removing the

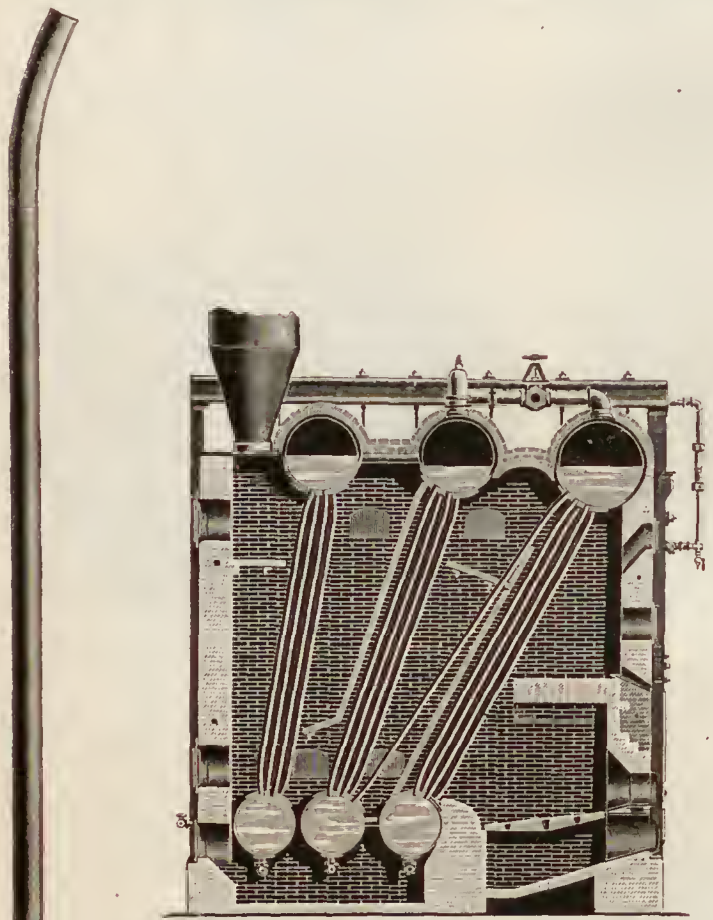


FIG. 34.—THE PIERPONT BOILER, 1893.
Trade Circular.

scale left by the evaporation of water, he not having attained to either of the theories of keeping it clean by the force of circulation or by evaporating salts of lime into steam. In one of his publications he recommended "for a boiler made of iron tubes, the use of one part of muriatic acid to 100 parts of water, to be left in the boiler a sufficient length of time to dissolve the incrustation; and for a boiler made of copper tubes, 1 lb. of salt, ½ lb. of sulphuric acid, and 4 galls. of water. When dissolved, a small fire was to be started, and the boiler blown out under pressure."

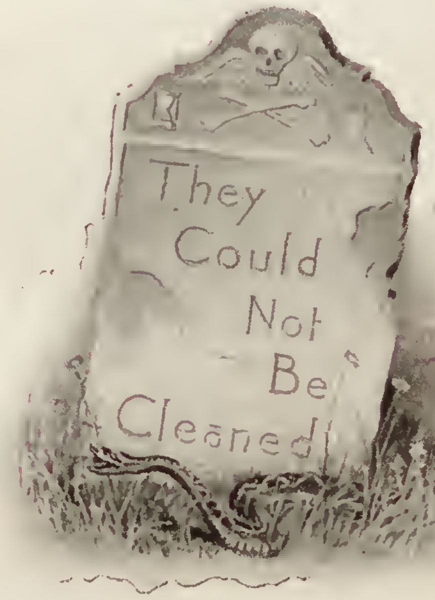
Later exploiters in this line, more versed in "commercial engineering," have generally advocated the rapid-circulation theory as an efficient cleaning medium.

One notable maker recommended the introduction of a couple of buckets of sharp sand into the boiler, claiming that the circulation would carry it around and *scour the scale from the tubes.* Whether or not he furnished a particular quality of sand that would just wear out at the point when the scale was removed, and so save wear on the boiler, we are not posted.

Another maker strung a tube scraper on a chain, like an old-fashioned chain pump. The man in the top drum let this down through one of the tubes (if the scale had not closed it up too much) to a man in the bottom drum, and these unfortunate specimens of humanity were supposed to sit like two half-closed jack-knives, see-sawing the scraper back and forth, until either the scale or their muscles were worn out.

The early designs were creditable attempts to carry high pressures safely, with the means then available. The later ones are all based on crowding the greatest possible amount of heating surface into a given space, at the least prime cost for material and labor, irrespective of either economy, durability, or good engineering.

In the majority of these designs it is impossible to clean a tube, to tell which tube leaks, or to replace a defective tube without removing several good ones.



(TO BE CONTINUED.)

NOTES AND NEWS.

New Car-wheel Works at Raleigh, N. C.—The new car-wheel works which have been built at Raleigh have just been started up. The Lobdell car-wheel people of Wilmington, Del., are largely interested in the new plant, the other stock being owned by local capitalists. The stock is $100,000. The works will have a capacity of 50 wheels a day, employing about 60 hands, and it is the intention gradually to increase the works, as they expect to sell to roads as far north as the Potomac River and in all the more Southern States. The iron ore used will come entirely from North Carolina and other Southern States. There is already a car factory at Raleigh which has been in existence for 12 years, and although that plant and the wheel works are separate concerns, they are built side by side and will operate largely in conjunction.

An Electrical Vehicle in London.—Details of an electrical bus built by E. J. Clubbe & Co., and which is now at work in the streets of London, has been received. It can carry 26 passengers, and its power is furnished by storage batteries carried under the seats. The motor is in a box hung between the back wheels to which the power is applied. The total weight of bus with load of passengers is a trifle over 6 tons, 2¼ of which belongs to the empty vehicle; it is under perfect control, and can be run at any desirable speed up to 10 miles an hour. The cost of operation is claimed to be less than 6 cents a mile, and it can make 580 miles a week.

THE DETERIORATION OF LOCOMOTIVE AND MARINE BOILERS DUE TO EXPANSION AND THE MEANS OF LESSENING THE SAME.*

By Herr Lentz.

(*Continued from page* 137.)

For 30 years, and even now, the beloved crown-bars have been applied in England, where they undoubtedly represent

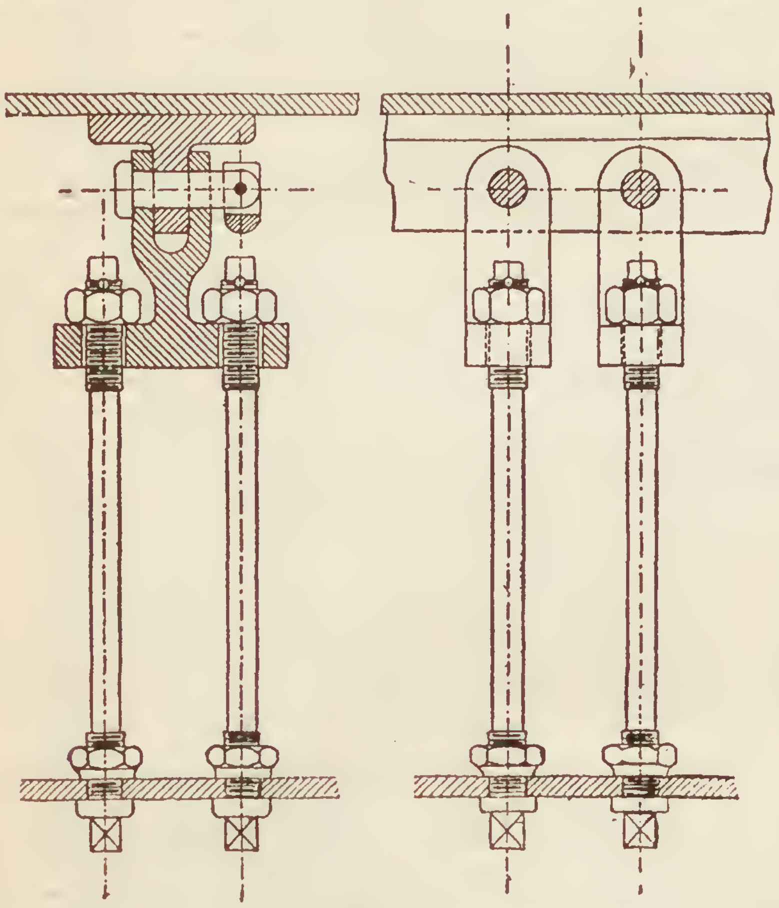


Fig. 7.

FLEXIBLE CROWN-SHEET STAYS FOR BELPAIRE BOILER.

the prevailing practice, since by reason of the play of the crown-bar suspension rods the vertical motion of the fire-box is in no way checked. Later the Belpaire arrangement of crown-sheet bracing came into vogue, which left the cross expansion free as far as the crown-sheet is concerned, but caused such a modification to be made in the half-round external shell of the fire-box that, while the construction is greatly simplified, the fire-box was made very much stiffer and the elasticity in a vertical direction is hampered. Hence unless the forward stay-bolts are susceptible of a slight motion the tube-sheet must be subjected to a heavy strain.

It is strongly recommended that in this fire-box movable stay-bolts be used in the four front rows and on both sides in the lateral rows. In the latest type of Belpaire boilers that have been introduced on the Belgian State railroads the crown-sheet is perfectly flat, and both the front rows of stay-bolts are movable and are made like that shown in fig. 7. The Pennsylvania Railroad has in use a very rational form of Belpaire fire-box on its locomotives with two rows of movable stay-bolts at the front and back (fig. 8). As stay-bolt holders must yield about $\frac{1}{8}$ in., as they are stiff, and as the stay-bolts sustain this bending in a length of about $2\frac{3}{8}$ in., there is a considerable inclination to break. This can be prevented by the Belgian method shown in fig. 9, wherein the connection to the tube-sheet is made over a long section that yields easily. It would therefore appear that the many breakages of stay-bolts that occur in the side-sheets result from the fact that they are not properly put in.

From the mud-ring up, all parts of the inner fire-box rise, so that we must in no way hinder this movement, but should put in the stay-bolts so that they can easily yield, and they should be screwed in horizontally, as correctly shown in fig. 4 (see page 135). Furthermore, stay-bolts should stand at right angles or radial to the sheets, so that they may serve for the support of the walls; otherwise they are in so unfavorable a position for carrying either a tensile or compression strain that they break. Investigations show that the front and back vertical rows, as well as the upper horizontal rows, are the ones that are especially liable to break. It is astonishing, moreover, to find what examples of preposterous arrangements of stay-bolts we find in American boilers, examples of which are given in fig. 10. The two halves of these cross-sections of fire-boxes are taken from boilers built by a prominent American shop for roads running into Chicago. In the Wootten fire-box, as well as in the other, the stay-bolts are set radially throughout. It is not clear where an allowance can be found for the greater expansion of the inner fire-box, but it does seem that both stay-bolts and fire-box must soon become distorted. Instead of using the Wootten fire-box, it would seem to be far more rational to substitute one of the Belpaire type.

Torpedo-boat boilers (fig. 11) that are for the most part built after the locomotive pattern, and which are subjected to violent forcing, whereby a very high steam production is attained with a correspondingly high temperature of the sheets, offer many difficulties in maintaining the tubes tight in the sheets. We screw the tubes into the fire-box tube-sheet as tightly as we can, then roll them out and head them over, and yet when we put them under a forced draft they will not remain tight. This trouble can be almost entirely obviated by making the tube-sheet at the smoke-box end flexible, as shown in fig. 12. The tubes are then free to expand. It is in a line with the recommendation that movable crown-stays and stay-bolts be used in all places where it may be necessary. The usual type of marine boiler of large diameter (fig. 13) with several furnaces and return tubes, whether it be made single or double ended, shows that a riveted connection of the furnace flues with the outer shell of the boiler and the combustion chamber and other portions will be very apt to be leaky. In order to hold the sheets together in a better manner it is essential that they should be stayed, and then there is less trouble about the riveting leaking.

It follows, then, that the portion of the flue above the grates becomes highly heated and is therefore expanded more than the outer shell, so that the sheets at the front end are forced together. Then, since the sheets are strongly braced by the tubes above, it results that the riveting is apt to be distorted where it lies in contact with the fire. This great evil can be removed if we will but give the furnace flue a free chance to expand by inserting a flexible ring, as shown in fig. 14. Movable stay-bolts placed along the rim of the fire-box will be found to materially help in allowing the tubes to expand longitudinally.

Locomotives with corrugated furnaces manifest phenomena similar to those mentioned for marine boilers, except that they

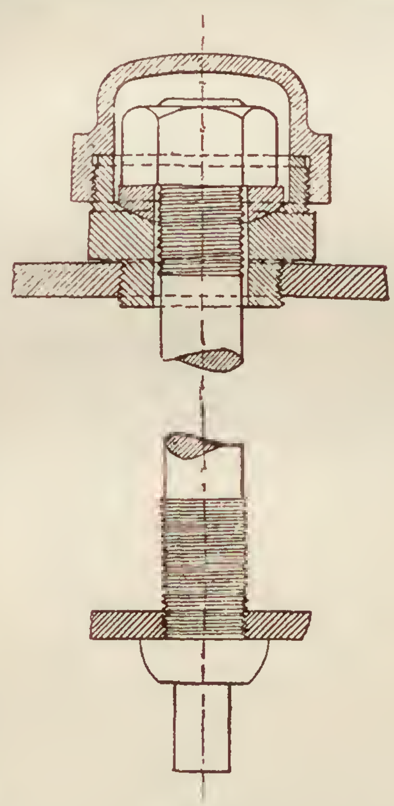


Fig. 8.

SELF-ADJUSTING STAY-BOLTS FOR BELPAIRE BOILERS USED ON AMERICAN RAILROADS.

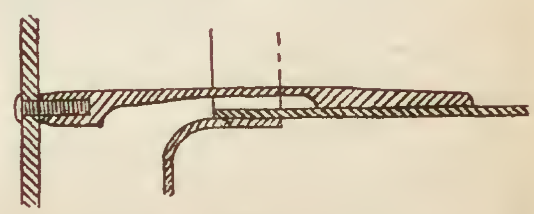


Fig. 9.

STAY-BOLT HOLDER FOR BELPAIRE BOILER ON THE BELGIAN STATE RAILWAY.

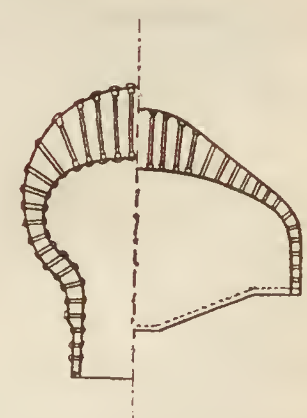


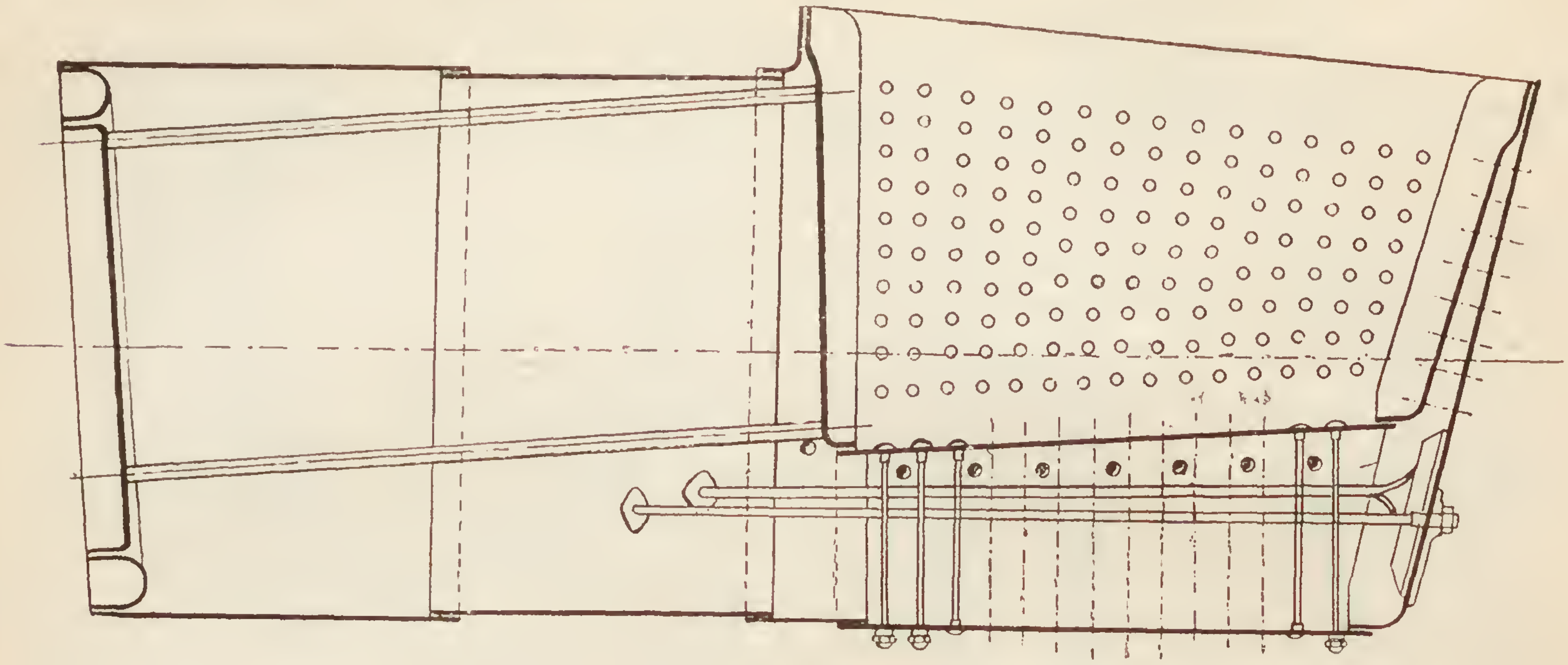
Fig. 10.

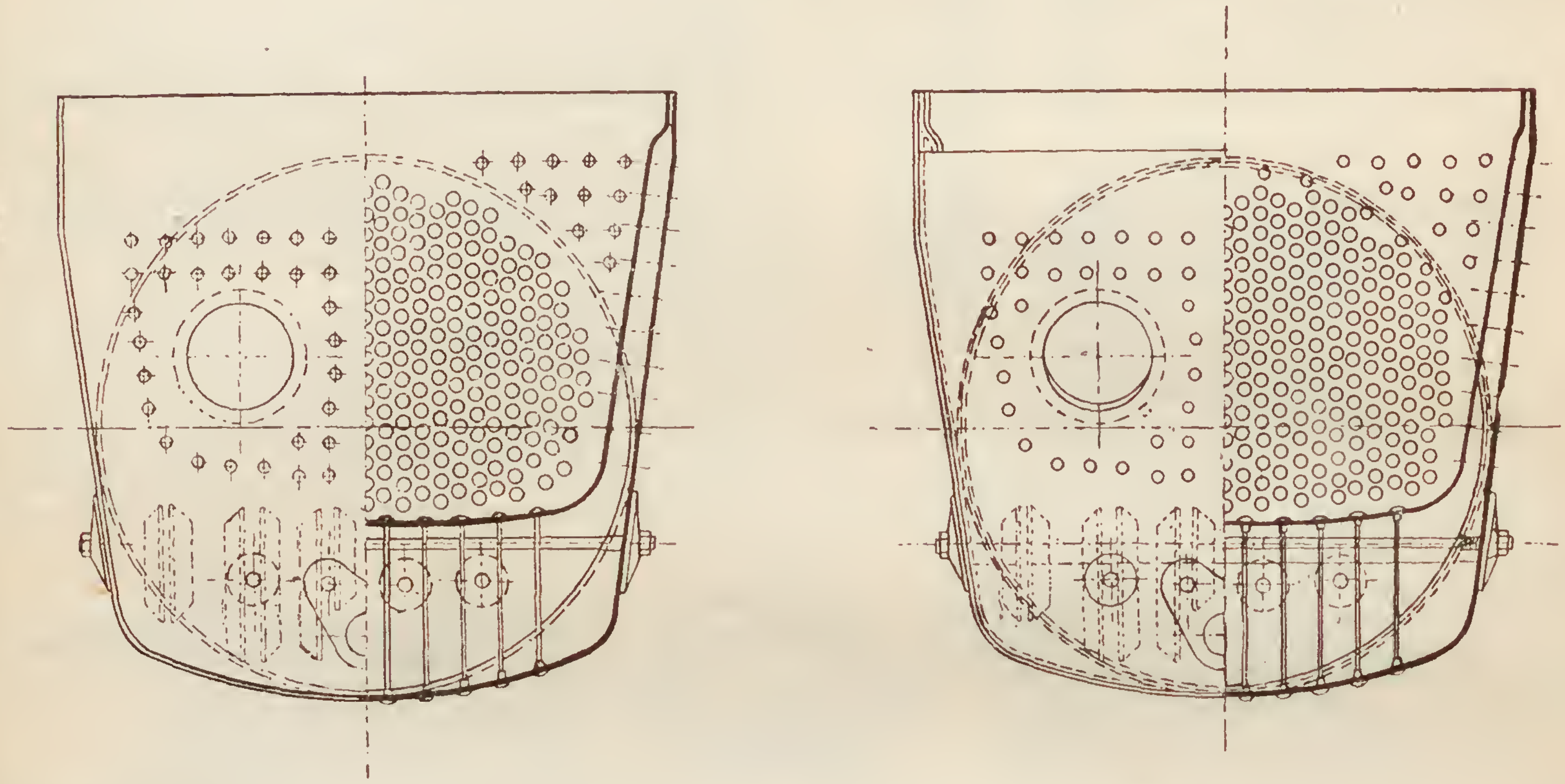
ARRANGEMENT OF STAY-BOLTS IN AMERICAN LOCOMOTIVE BOILERS.

* Paper read before the *Verein für Eisenbahnkunde*.

Fig. 11.

OLD CONSTRUCTION OF TORPEDO-BOAT BOILERS.





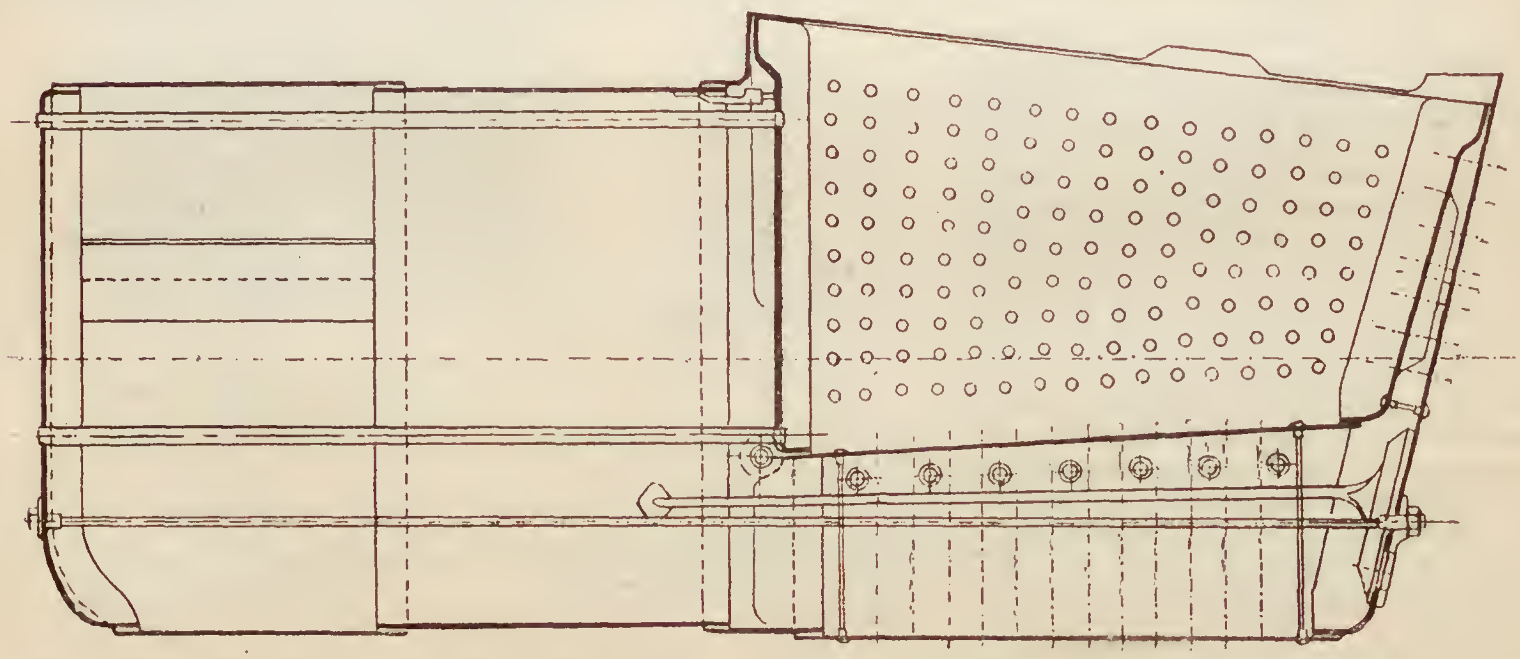


Fig. 12.

TORPEDO-BOAT BOILERS WITH FLEXIBLE TUBE-SHEETS AND SELF-ADJUSTING STAY-BOLTS.

are exaggerated over the latter in that the expansion of the furnace must be added to that of the tubes. In the stayless boiler the back end of the corrugated furnace is rigidly fastened to the outer shell of the boiler, while at the front end there is a strong and rigidly attached smoke-box tube sheet, so that the excess of expansion of the inner portion can only take place in the corrugated flue.

The general impression is that the corrugated furnace flue is very elastic longitudinally, yet the experiments of Schulz-Knaudt, which have extended over a period of two and a half years, and which have been fully published in *Glaser's Annalen*, show that the compressibility is very limited, and with the greater thicknesses of metal the limit of elasticity is soon reached. While these experiments were made with cold flues, it must be remembered that, at higher temperatures, the limit of elasticity will be reached much earlier, so that care must be taken that this limit of elasticity is not exceeded and a deformation set up which will manifest itself in the form of a crack.

Herewith an engraving (fig. 15) is given showing the construction of a stayless boiler in use on an express passenger locomotive running on the railway along the left bank of the Rhine, and which had the misfortune to collapse the corrugated flue at Bonn on February 6, 1894. That the catastrophe partook of the nature of an explosion was due to the fact that the lower side struck against the edge of the iron casting that carried the fire-brick, which had worn smoothly into the sound material for about a foot; this cross seam then extended about 4 in. sideways and ripped open the whole length. Had no iron casting for carrying the fire-brick been used, but all the fire-

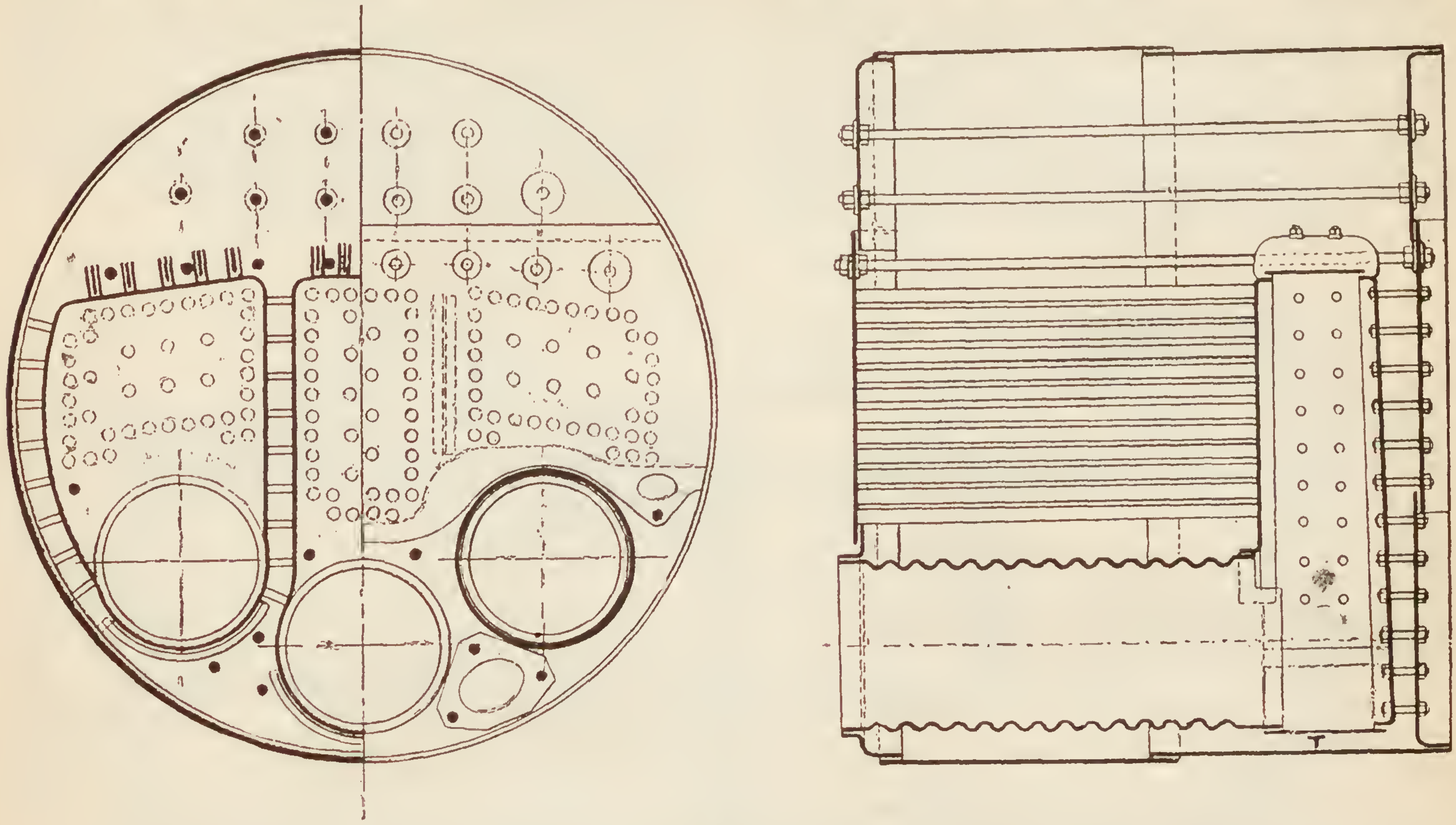


Fig. 13.
OLD CONSTRUCTION OF MARINE BOILER.

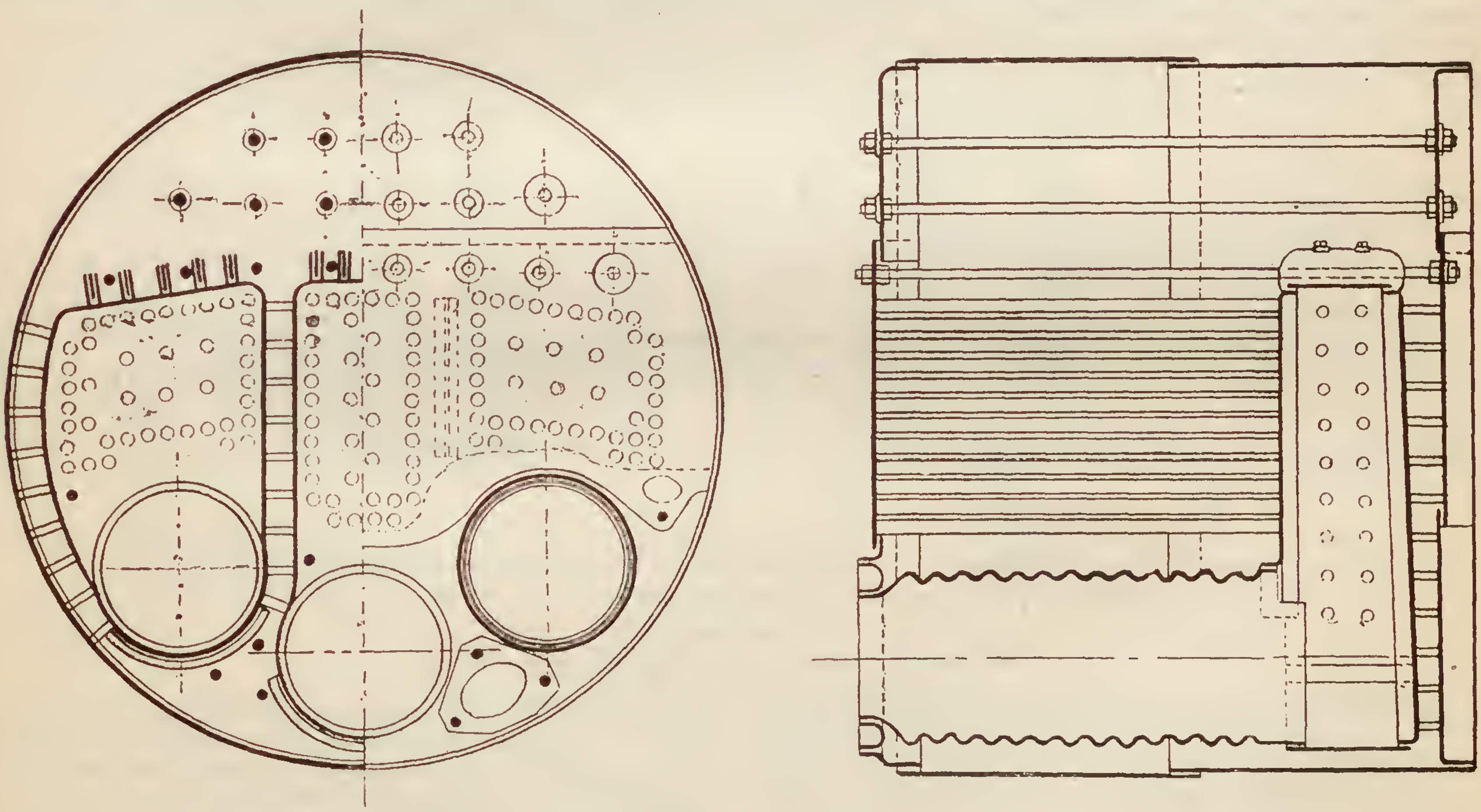


Fig. 14.
MARINE BOILER WITH FLEXIBLE RING FOR THE CORRUGATED FLUE.

brick been put in with mason work, there would simply have been a collapsing without a rent, and no steam would have escaped, nor would the accident have partaken of the nature of an explosion.

The corrugations had been put in by hand, and were, therefore, imperfect, but they were strong enough to withstand the collapsing pressure to which they were subjected, for they did withstand the yielding of the sheet perfectly. It was a true case of collapsing, such as we sometimes witness in marine boilers. The reasons for this sudden deformation could not at first be found. The first supposition attributed it to low water, which should have shown a long, narrow line corresponding to the point where the contained matter had boiled on, whereas in this case it was extended over the whole surface. Then an explanation was sought in the scale that contained magnesia and fatty matter, which might result from the water standing, and which, on analysis, was shown to contain from 12 to 22 per cent. of the hydrate of magnesia, with just a trace of fatty matter.

The analysis showing the highest percentage of scale was of scale taken from an express passenger locomotive running on the left bank of the Rhine Railway. If now a layer of scale of the same thickness was spread over both the corrugated flue and a copper fire-box it is evident that the same temperature must exist in both cases. The temperature could not reach 1,100° F., since at that point the tensile strength of the copper would disappear, and the stay-bolts would be stripped out of the crown-sheet. We may take 925° F. as the highest possible limit of this temperature, and even here the tensile strength of the copper is only 7,100 lbs. per square inch, and we are well warranted in thinking that it would strip off the stay-bolts.

At this same temperature of 925° the tensile strength of wrought iron is 42,600 lbs. and the limit of elasticity 14,200 lbs., so that with a steam pressure of 14 atmospheres, as we have had in this case, we would not expect to find any deformation; and even at 1,300°, where the metal begins to show a dark-red color, it still has a tensile strength of 14,200 lbs. per square inch, which is still sufficient to resist the pressure provided that the corrugated tube preserves its circular form of cross section. Measurements taken of furnaces which were removed from locomotives soon after this accident, and which had been in service for a longer time, showed that in boilers which could not be considered strong the corrugated furnaces had changed neither in length nor in cross section, while, on the other hand, boiler shells have shown a variation of $\frac{5}{16}$ in. on the upper and $\frac{1}{16}$ in. on the lower side, and there has likewise been a flattening out to the extent of 1.2 in. that seemed to be confined entirely to the upper half, the lower remaining circular. This 1.2 in. was the difference in the lengths of the horizontal and vertical axes, so that the variation of either one from the proper mean diameter of shell was 0.6 in.

(TO BE CONTINUED.)

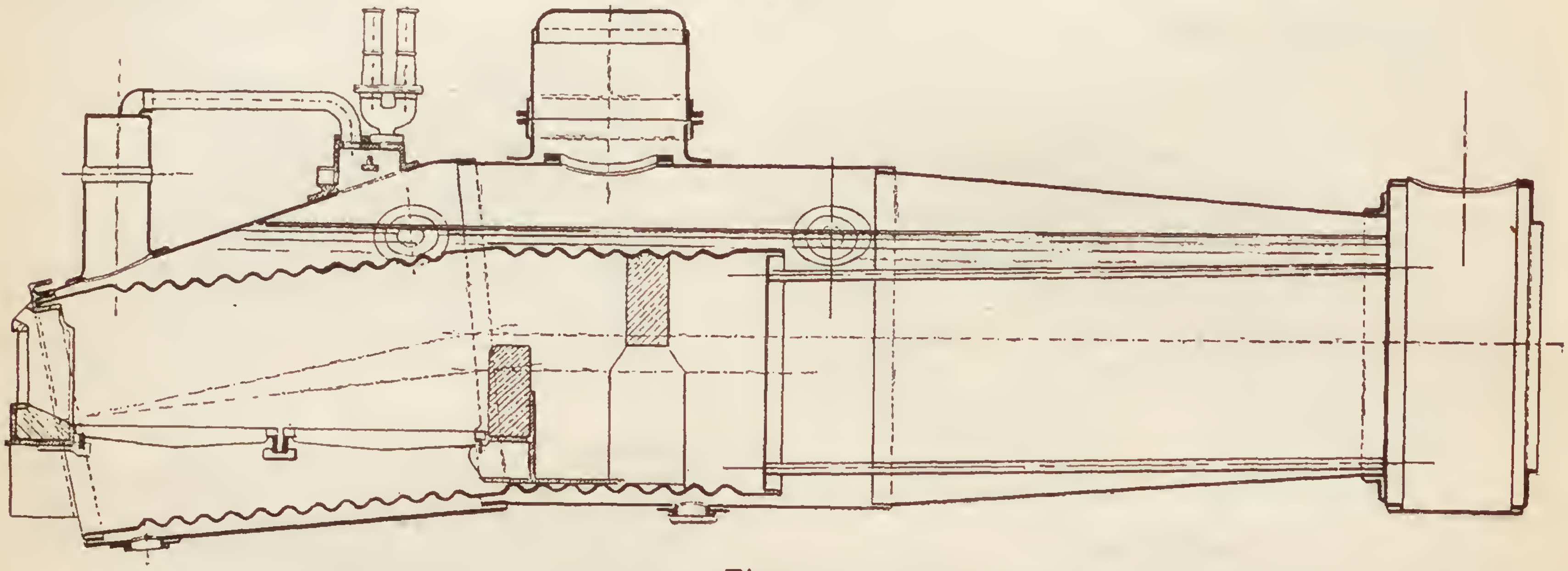


Fig. 15.
STAYLESS BOILER ON EXPRESS PASSENGER LOCOMOTIVE OF THE LEFT-BANK-OF-THE-RHINE RAILWAY.

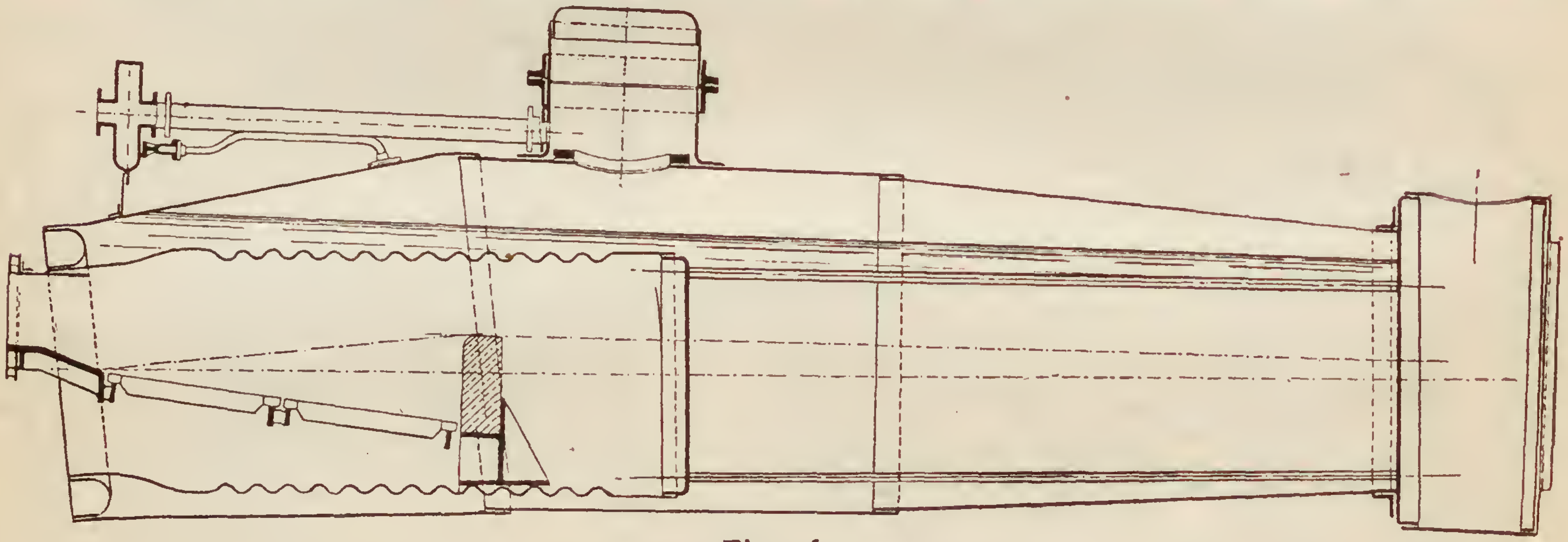


Fig. 16.
STAYLESS BOILER WITH FLEXIBLE BACK HEAD.

FAY'S ENGINE VALVE.

It is well known that one of the defects of the ordinary Howe or Stephenson link-motion valve-gear is that when working at short points of cut-off it causes an excessive amount of compression in the cylinder by the premature closing of the exhaust some time before the piston has completed its stroke. The object of Fay's engine valve is to reduce the amount of this compression. This is effected by means of supplementary steam ports and passages in the valve and cylinder, whose construction and arrangement is shown in the engravings herewith. Fig. 1 is a longitudinal section of a locomotive cylinder, and valve, the portion on the left-hand side of the centre line *A B* being drawn on the lines *A* 1 2 *B* of fig. 2, and the portion on the right side of *A B* is drawn on the line *C D* 2 *B*. Fig. 2 is a transverse section drawn through the supplementary passages *a* and *a'*, and also shows the main steam passage *c'* in section in order to represent the way in which communication is formed between the latter and the supplementary passages *a* and *a'*. Fig. 3 is a plan view of the cylinder, in which a half sectional plan of the valve drawn on the line *d e* of fig. 1 is shown on the lower half below the centre line *E F*. Fig. 4 is an inverted plan of the valve, its face being shaded with horizontal lines in order to show the form of the supplementary ports *f* and *f'* more clearly.

The general purpose of the invention is to establish communication between the end of the cylinder toward which the piston is moving and the opposite end after compression has commenced in the former and the latter is in communication with the exhaust. By the means which are provided the compressed steam can flow through the supplementary ports and passages to the opposite end of the cylinder, and can then escape into the exhaust. To accomplish this supplementary passage a and b, consisting of holes about $\frac{3}{8}$ in. in diameter, are drilled from the valve face $G\ G$, so as to communicate with the inside of the cylinder, the openings g and h, which communicate with the latter, being so located that they are uncovered by the piston about the time—or soon after—compression has commenced, and it has then uncovered the opening h, by which the passage a communicates with the inside of the cylinder. The valve is also shown in the position it would occupy soon after compression has commenced in the left-hand end H of the cylinder when the steam port c, which communicates with the opposite end of the cylinder, is opened to the exhaust. When the valve has reached this position the extremities of the groove f' in the valve face lap over the openings $j\ j'$ in the valve-seat, as shown in figs. 1 and 3. Communication is thus established between the right-hand end H of the cylinder through the steam passage c' (shown by dotted lines in fig. 1), the groove f', openings j and j', and passages a and a' to the left-hand end I of the cylinder; and as this is in com-

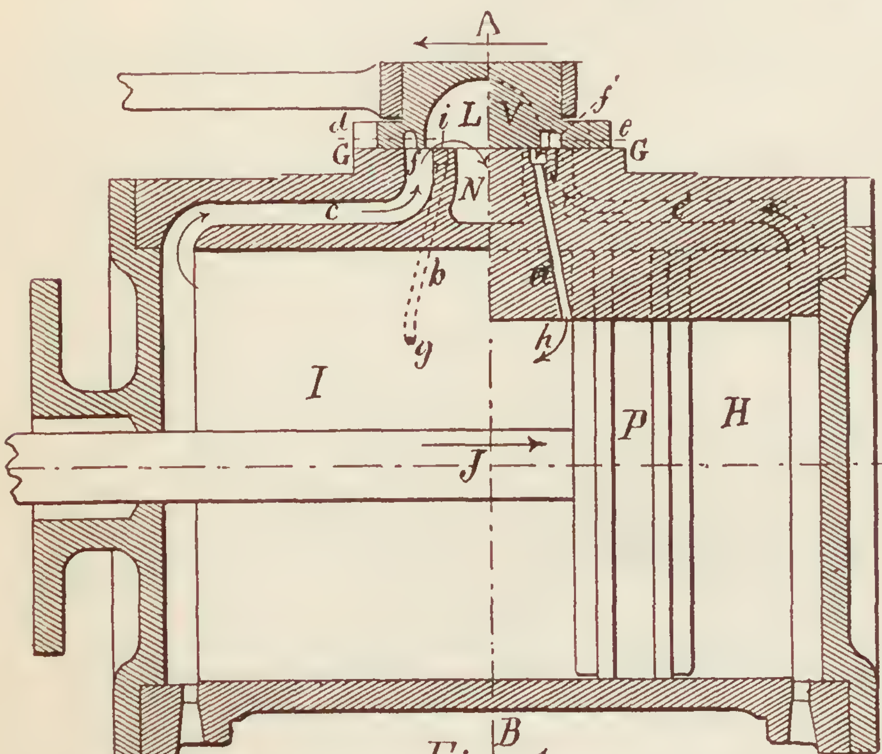


Fig. 1

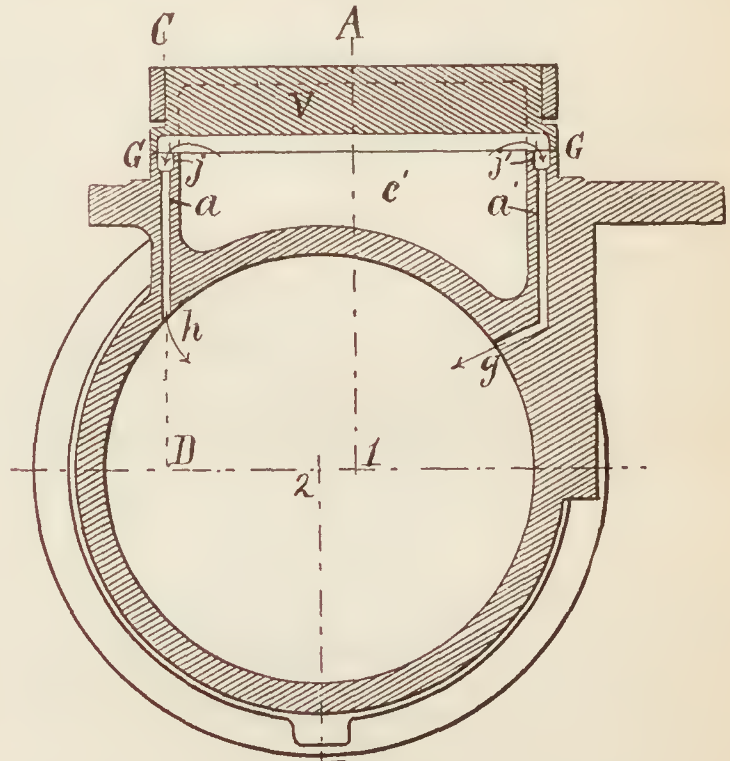


Fig. 2.

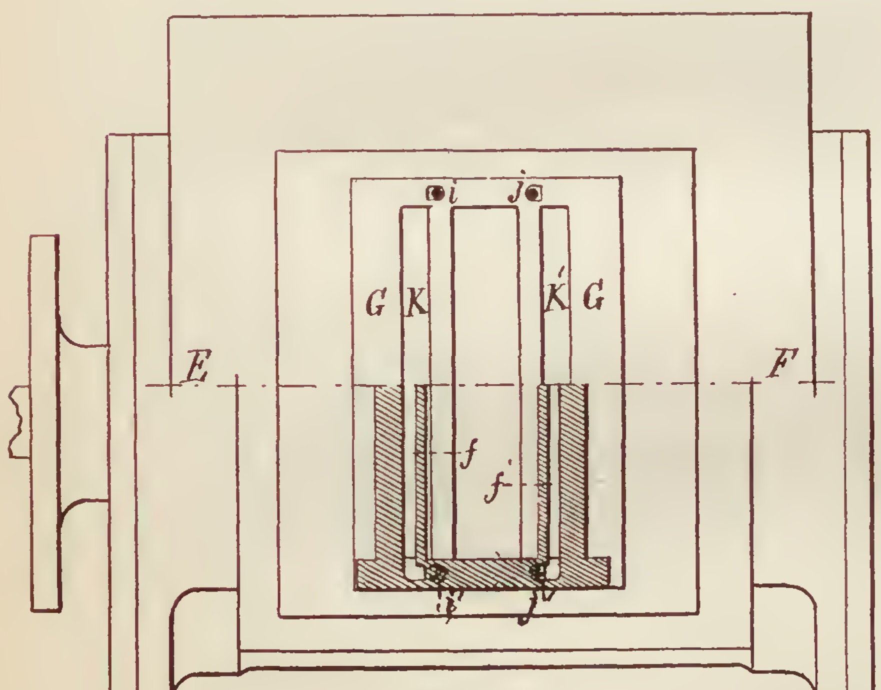


Fig. 3.

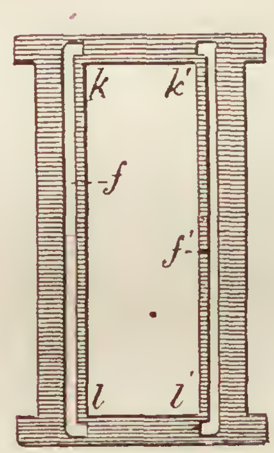


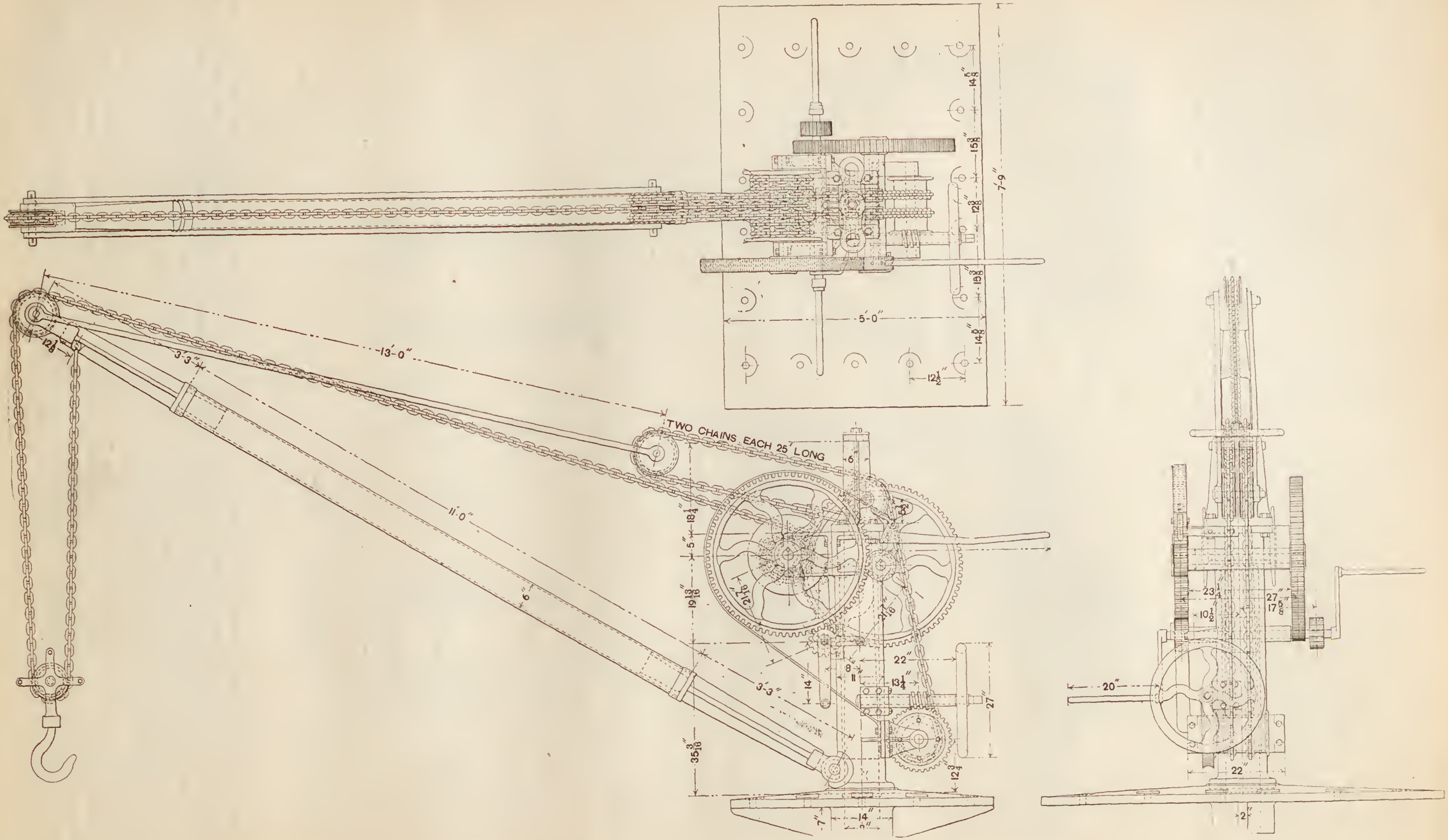
Fig 4

FAY'S ENGINE VALVE.

begins. In order to open communication between these supplementary passages and the main steam passages c and c', grooves f and f' (see fig. 4) are cut in the face of the valve. The openings i and j of the passages a and b in the valve-seat $G\ G$ are enlarged somewhat, so that their outer edges are in line, or nearly so, with the inner edges of the steam ports $K\ K'$, as shown in fig. 3, and the extremities of the grooves $f\ f'$ in the valve face are also enlarged, so that their inner edges conform very closely to the exhaust edges $k\ l$ and $k'\ l'$ of the valve, as shown in fig. 4.

In fig. 1 the piston P is supposed to be moving in the direction indicated by the dart J, and the direction of the movement of the valve V is indicated by the dart A. The piston is shown in the position it would occupy soon after compression munication through the passage c, with the exhaust cavity L in the valve and the exhaust pipe N, it is evident that the steam which is compressed in H can thus escape to the exhaust pipe, and that the back pressure will thus be relieved in front of the piston. Of course an exactly similar action takes place at the other end of the cylinder when the piston moves in the opposite direction.

This device has been applied to a number of locomotives on the Boston & Albany Railroad, and also to a small experimental stationary engine, and tests have been made with both, which show not only a very material diminution of compression, but indicator diagrams also showed that the expansion line was raised and the back pressure lowered. The reasons for the latter are somewhat obscure. The stationary en-



FIVE-TON CRANE FOR WRECKING CAR. BUILT AT THE SHOPS OF THE PHILADELPHIA & READING RAILROAD, AT READING, PA.

gine was so arranged that the supplementary passages could be opened or closed at pleasure, and experiments showed that when running with a constant load at 302 revolutions per minute the speed was increased to 340 revolutions by opening the supplementary passages. We have no reports of the fuel consumption of engines with and of those without this device. It is in such reports that its ultimate advantage must show itself, if it has any. The extreme simplicity of the arrangement commends it. There is not a single piece added to the engine, but only a few holes. The inventor is Henry R. Fay, whose address is No. 8 Exchange Place, Boston, Mass.

WRECKING CRANE, PHILADELPHIA & READING RAILROAD.

THE Philadelphia & Reading Railroad have in service at the Third and Berks streets Station, in Philadelphia, a wrecking crane that is of a very simple construction, and could be easily duplicated by any road desiring to build such a crane and wrecking car for its own use. This crane, or, rather, these cranes and the car were built at the Reading shops of the company. There are two cranes on the car, and they are stepped over the trucks at either end. The car is equipped in the usual manner with holding-down clamps that take hold of the rails at the four corners, and the platform is further steadied by jacks placed on the arch-bars of the trucks directly over the oil-boxes. Nearly the whole space beneath the sills and between the trucks is occupied by a deep tool-box, while extra trucks with a supply of blocking are packed on the platform between the crane-posts. The main body of the jib is made of a piece of 6-in. gas pipe slipped over and riveted to castings at either end that carry the foot of the jib and the hoisting sheave respectively. The jib is raised and lowered by means of a wheel 27 in. in diameter operating a worm that meshes in with a gear, as shown in the engraving of the side elevation. This worm wheel has a pitch diameter of $13\frac{27}{32}$ in. with a face $2\frac{1}{4}$ in. wide, and has 33 teeth of $1\frac{1}{4}$-in. pitch. The chain for raising the jib is wound directly on the spool to which the worm gear is keyed, and has a double purchase on the stay as shown. Provision is made for slow and rapid hoisting by throwing the first set of hoisting pinions in or out of gear. Instead of having a brake wheel for lowering, the brake strap is made to act directly upon the teeth of the main gear on the hoisting drum. Although the crane has been in service for some time, there is no apparent wear on the ends of the teeth. The crane has been designed for construction with the minimum amount of pattern work, inasmuch as only two of the kind were wanted. As the principal dimensions are given on the engraving, no recapitulation of them will be necessary. The capacity of the crane is five tons, thus giving the crew the power to hoist a weight of 20,000 lbs. with the two.

THE CRUISER "CINCINNATI."

THE cruiser *Cincinnati* is a vessel of 3,100 tons displacement, and in addition to the battery described in a previous number, she carries three torpedo tubes, one in the bow, for fire ahead, and two in the compartment just abaft the engine-rooms, for broadside fire. Just forward of the foremast and abaft the mainmast, on platforms about 10 ft. above the decks, are two 16,000-candle-power search lights. On a line up and down the foremast are the electrical signal lights of the Ardois system. These are for signalling at night. In the space between the forecastle and poop-decks, and on the same level, are the cradles and tracks for carrying the boats, which consist of one steam launch, one sailing launch, four cutters, two whaleboats, and a dingy. A fore-and-aft bridge runs between forecastle and poop, which permits of free communication to both ends of the vessel on this deck. Above the forecastle is the armored conning-tower, inside of which is the steering wheel, compass, engine-room annunciators and speaking-tubes to all parts of the ship. Above the conning-tower is the bridge, upon which are the same fittings as in the conning-tower. The vessel may be steered from four different and independent places—viz., bridge, conning-tower, poop-deck and steering-engine-room under the protective-deck.

On the gun-deck, under the forecastle, are the closets for the crew, ice machine, anchor engine and galley. In the waste amidships are the engine and fire-room, hatches, firemen's wash-room and shower-bath, evaporator and distiller-rooms and engineer's workshop.

Under the poop are the ward-room officers' mess-room and pantry and two staterooms on the port side and four staterooms on the starboard side. Aft of these come the captain's cabins, occupying the entire after part of the space under the poop. The cabins consist of a forward and an after cabin, stateroom, bathroom and pantry. These cabins are furnished handsomely, having upholstered transoms and chairs, beautiful rugs and *portières*, sideboard and polished table. In the pantry, in racks and on hooks, are the silverware and china for the cabin. In bookcases around the forward cabin is the library furnished to the vessel by the Government. This is for the use of the officers, and consists of numerous books of travel, memoirs of officers, histories, ancient and modern, professional works and standard novels. The captain's stateroom is just off the forward cabin, and is furnished with a bunk, wardrobe, bureau, heater and transom. His bath is just off this stateroom. The after cabin is much smaller than the forward cabin, but is fitted in much the same way. In it are the two 1-pdr. rapid-fire guns.

Every part of the cabins and other officers' quarters is finished in polished hard wood.

On the berth-deck forward is the bow torpedo tube, sick bay and dispensary with closet and bath for same. Aft of these is the berthing space for the crew, together with the prison. Two passages, one on each side, run fore and aft over the boilers, coming into one passage over the engines, and continuing aft, allowing free communication fore and aft on this deck. Outboard of these passages and over the protective-deck are coal bunkers extending up to the under side of the gun-deck. On the slope of the protective-deck outboard is a coffer-dam of cellulose as a protection from shot. In the compartment just aft of the engine-rooms is a torpedo-room having one broadside torpedo-tube on each side, together with their training tracks and gear and racks for stowing torpedoes. In this compartment are also the paymaster's and engineer's offices, the remaining space being used as berthing space for the crew.

In the next compartment abaft the torpedo-room is the junior officers' mess-room on the starboard side, and the warrant officers' mess and staterooms on the port side. In the next compartment aft are the officers' staterooms, the two forward rooms being fitted with two bunks each for junior officers, and the other rooms with single bunks for ward-room officers. In the next compartment aft are two bathrooms and four closets for officers; and the next compartment, which is in the extreme after end of the vessel on this deck, is used as a cabin storeroom. Below the berth-deck is the steel protective, running the entire length of the vessel and sloping down below the water-line at the bow, stern and sides. Over the engines and boilers, and inside the two smoke pipes, heavy steel gratings, called armor gratings, are fitted instead of the solid steel deck. This is done to allow for ventilation in engine and fire rooms, and at the same time protect the machinery and boilers from damage by shot. The protective-deck is 1 in. thick on the top, 2 in. on the side slopes and $1\frac{1}{2}$ in. on the bow and stern slopes. This deck, together with the coal, protects the vitals of the vessel—viz., engines, boilers, magazines, shell-rooms, dynamos and steering engine.

Below the protective-deck, forward and aft of the engine and fire-room compartments, are short decks called the platform-decks. On the forward platform deck are the electrical, torpedo, paymaster's, ordnance and construction storerooms, dynamos and appliances. On the after platform-deck are paymaster's and engineer's storerooms and the steam steering engine and steering wheel.

Below the platform-deck is the hold, which runs as the platform-deck, from fire-room compartments forward and from engine-room compartments aft. On the bow of the vessel on this deck is the forward trimming tank; aft of this come the wet provision storeroom, then the magazines and shell-rooms, which latter, in addition to being below the water-line and under protective-deck, are protected by coal on the outboard sides. The after hold has the after magazines and shell-rooms, engineer and ward-room storerooms, and in the extreme after end the stern trimming tank. Each engine-room is a water-tight compartment in itself, a fore-and-aft bulkhead running between them, extending from inner bottom to under side of gun-deck. A fore-and-aft passage runs between the boilers, having a bulkhead on either side extending from inner bottom to gun-deck, and over the middle boilers passes a thwartship bulkhead, thus dividing the boiler space into four separate water-tight compartments. At the forward end of the forward boilers is a thwartship coal bunker, running the entire width of the ship, thus affording additional protection in case of a shot coming in the bow and passing aft.

Below the engine and fire-rooms and fore-and-after holds are the inner and outer bottoms, the space between being divided into separate water-tight compartments by means of the keelson running fore and aft and some of the frames of the ship

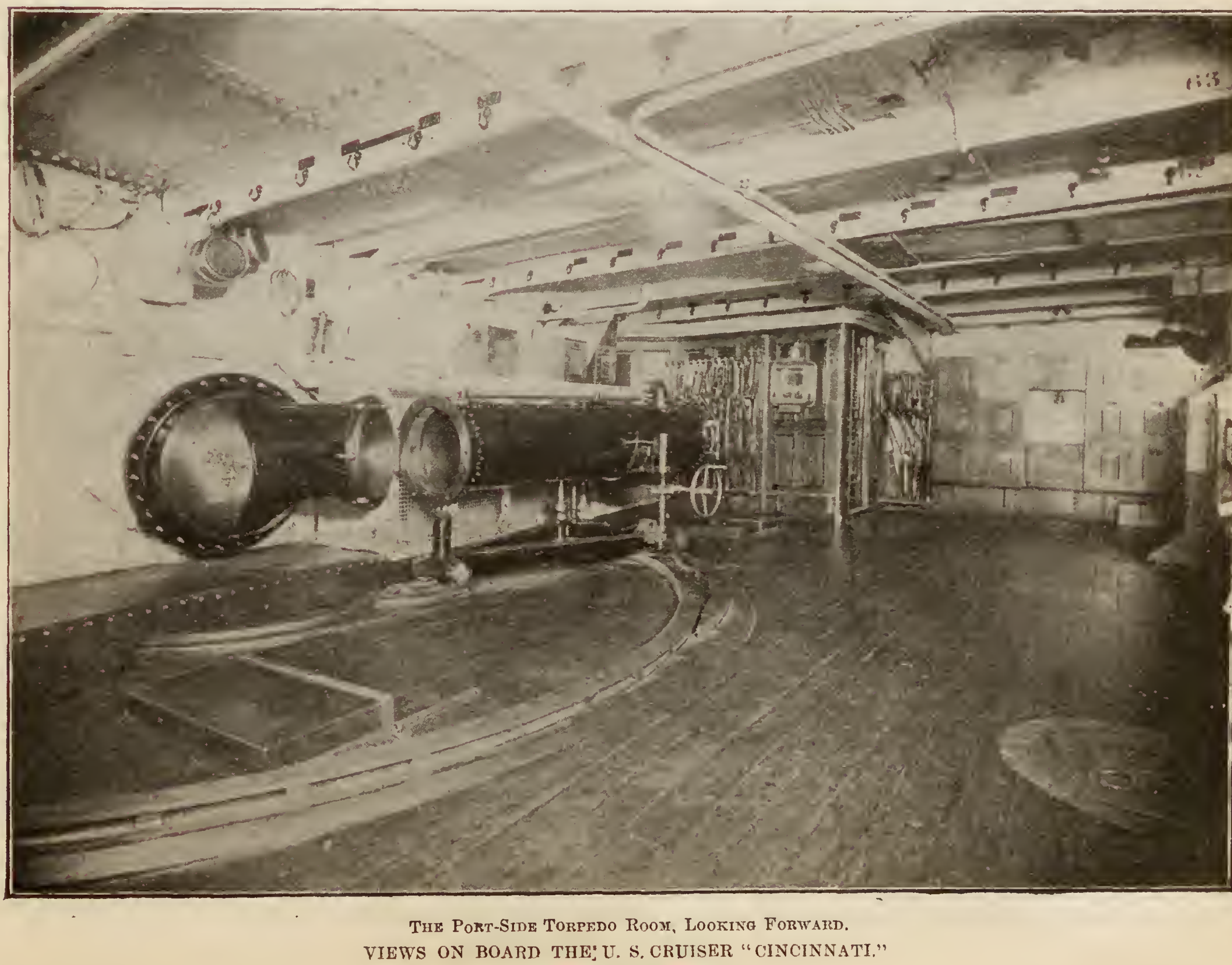
The Poop-Deck, Looking Aft.

The Captain's Cabin, Looking Aft.

VIEWS ON BOARD THE U. S. CRUISER "CINCINNATI."

(Photographed by Hart, Brooklyn, N. Y.)

The Gun Deck, Starboard Side, Looking Forward.



The Port-Side Torpedo Room, Looking Forward.

VIEWS ON BOARD THE U. S. CRUISER "CINCINNATI."

(Photographed by Hart, Brooklyn, N. Y.)

being built solid. Water-tight manholes and plates are fitted to allow communication with all parts of the double bottoms. The efficiency of these double bottoms was clearly proven during the recent accident to this vessel by striking a sunken wreck near Hell Gate. The outer bottom was pierced in many places, flooding the double-bottom compartments, but the inner bottom remained intact, thus saving the vessel.

Into all the compartments are run suctions to the drainage system, so that any compartment may be pumped out at any time, and by closing the water-tight doors, only one or two compartments will be flooded in case of accident.

The magazines and shell-rooms are fitted with flooding cocks, which allow of these compartments being flooded from the sea at a moment's notice. A complete fire main runs the entire length of the vessel, having nozzles on all decks for use in case of fire, and hose reels are located as near the nozzles as possible. There is also a complete ventilating system throughout the ship, the ducts running from the ventilators fore and aft, having nozzles in each compartment and stateroom.

Coal is carried in the bunkers on the outboard sides of the engine, fire-room and magazine compartments, and extends from the inner bottom up to the under side of the gun-deck, being both above and below the protective-deck. There are 12 bunkers above the protective-deck with a capacity of 262 tons and 18 below with a capacity of 196 tons. In addition 10 tons may be carried in bags and stowed below, making a total capacity of 468 tons. This could be brought up to 500 tons by stowing some in bags on deck without interfering with the management of the ship. The electrical plant is complete in every respect; in addition to the stationary incandescent lights there are numerous portable lights for use in remote parts of the vessel.

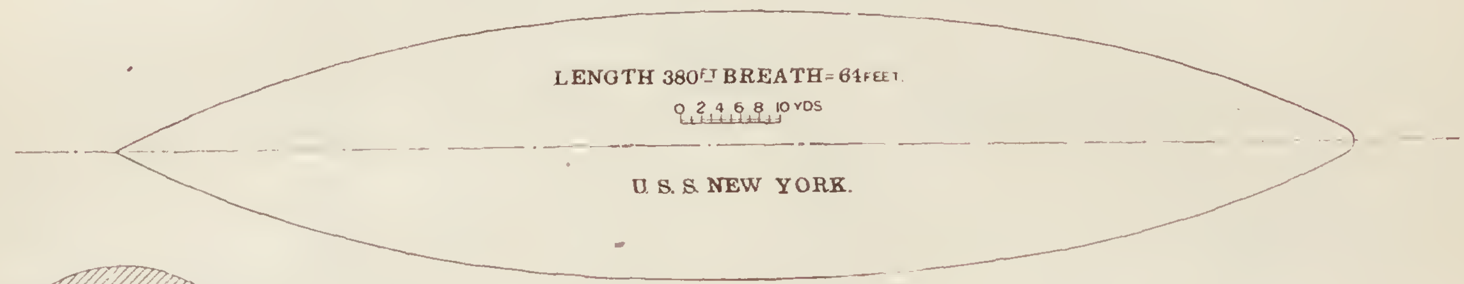
Taking everything into consideration, the *Cincinnati* is one of our best-equipped, most formidable and fastest cruisers.

TESTS OF THE PNEUMATIC GUNS.

In our issue for September, 1894, we illustrated and described the pneumatic dynamite guns that have been placed at Sandy Hook for the protection of the channels entering New York Harbor. Our readers will remember that this battery consists of one 8-in. and two 15-in. guns, built by the Pneumatic Torpedo & Construction Company. For the details of the arrangement and construction of the battery we refer to our previous article.

As the guns were built under a contract with the Government, wherein the latter assumed no responsibility except to pay for the guns, provided they fulfilled the requirements of the agreement, it was of the utmost importance that the performance of the guns should be such that the most exacting board could find nothing to criticise. The testing of these guns had been carried on for some time under the auspices of the company's officers, and an elaborate system of records preserved showing the fall in pressure in the air cylinders for various air and service charges, the former corresponding to blank cartridges in the ordinary rifle. After a long series of such trials, in which the setting of the valve was carefully observed for ranges and action, the official acceptance test was made.

The endurance test of the whole plant was, as given in our previous account, 50 rounds in the first hour, 20 being from the 8 in. gun and 15 from each of the two 15-in.; then, for the next two hours, 30 rounds per hour. These were merely "air shots," but the valve was set for extreme range. The results of this excessive trial, that far exceeded anything the battery could ever be called upon to meet in service, were that 50 shots were fired in the first hour, 33 in the second and 36 in the third. The initial air pressure at the firing of the first shot was 1,008 lbs. per square inch, and though this was not exceeded at any time during the trial, it was touched at several times during the second and third hours. The lowest point touched by the pressure was 930 lbs., at which the sixth shot in the



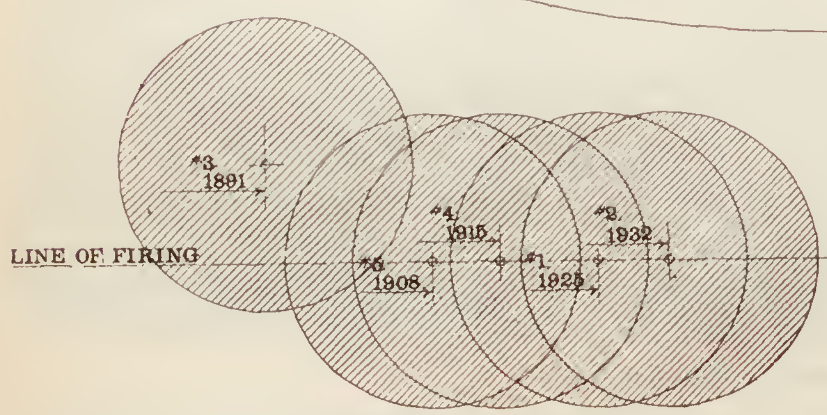


Fig. 1.

PLOTTING OF SHOTS FROM 15-IN. GUN WITH FULL CALIBRE PROJECTILES AND 500 LBS. OF EXPLOSIVE.

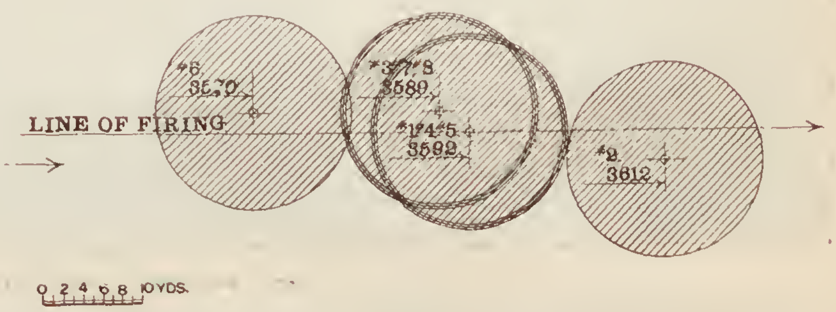


Fig. 2.

PLOTTING OF SHOTS FROM 15-IN. GUN WITH 10-IN. SUB-CALIBRE PROJECTILES AND 200 LBS. OF EXPLOSIVE.

PLOTTING OF SHOTS FROM PNEUMATIC DYNAMITE GUNS AT SANDY HOOK, N. J.

third hour was fired. It may be roughly stated that a firing pressure of 1,000 lbs. was maintained throughout, and no shot, with the single exception of the one mentioned, was fired at less than 990 lbs.

We have mentioned this endurance test first because it depended upon the machinery of the steam plant for its execution, although it was the last on the list.

The development of the pneumatic gun—for it has been a case of development—started with the fundamental idea of throwing a charge of dynamite with compressed air; and it having been demonstrated that this could be done, it became necessary to so control the admission of the air that the shot could be fired accurately, for it would be of little use in hurling dynamite about unless there is some probability of its striking the object at which it is aimed, and at this point the development of the gun came in as exemplified by the wonderful valve designed by Captain Rapieff.

It is useless to deny that the original guns were inaccurate, but this does not hold good of the present battery at Sandy Hook. Through the courtesy of the company, we are enabled to give diagrams of the targets of three sets of these shots. The striking point of the shots was located by means of plane tables. For the shorter ranges there were two observers stationed on either side of the battery, at distances of 596 yds. to the right and 627 yds. to the left; while, for the longer ranges, there was a third observer on the Romer Shoals beacon, which stood off from the line of firing at an angle of 17° 19′ and a distance of 5,150 yds.

It would be uninteresting to our readers to recapitulate the results obtained by each shot, and we therefore confine ourselves to the sets that are here plotted. In fig. 4 it will be observed that there is a plotting of the zones of danger to a first-class armored vessel due to the explosion of 500 lbs., 200 lbs. and 100 lbs. of high explosive respectively, as plotted from the formula of General Abbot. The plotting of the three sets of shots is done on this same scale.

Referring to fig. 1, which represents the plotting of five shots fired from the 15-in. gun with 500 lbs. of explosive in

each shot. The specifications required that 74 per cent. of these shots should fall within the area of a rectangle 120 yds. long and 30 yds. wide. As a matter of fact, the whole five fell within a rectangle 41 yds. long and 10 yds. wide, while four out of the five fell on the line of fire. Fig. 2 is the similar plotting, eight shots containing 200 lbs. of explosive that fell within a rectangle 42 yds. long and 5 yds. wide, whereas the specifications only required that $54\frac{1}{2}$ per cent. should fall within a rectangle 120 yds. long and 30 yds. wide. This fig. 2 represents the extreme contract range, and the figures appended to the striking point of each shot indicate the distance from the battery at which it struck the water. Fig. 3 is a similar plotting of shots containing 100 lbs. of explosive fired from the 8-in. gun, and shows that the five shots fell within a rectangle 57 yds. long and $3\frac{2}{3}$ yds. wide,* while the specification target was 120 yds. long and 30 yds. wide, with 66 per cent. hits required. We may therefore safely conclude that the accuracy of fire of these guns stands at a high point.

In our September issue we stated that these guns "command the whole southern approach to New York Harbor." An actual plotting of the ranges shows that the 15-in. guns can throw 200-lbs. charges to any point along the main channel for a distance of about 9,000 yds., and for 4,200 yds. through the swash channel. If a vessel were to enter the harbor at a speed of 20 miles per hour, it would, therefore, be exposed to the fire of the 15-in. guns with 200-lbs. charges for 16 minutes if it were running the main channel and $7\frac{1}{2}$ minutes if it were in the swash channel. In the first case the two guns could throw 20 projectiles, and in the latter 10 projectiles. Further, the guns are capable of throwing 500-lbs. projectiles to any point for a distance of 4,300 yds. along the main channel, and could fire eight projectiles at a vessel running 20 miles an hour before it was out of range, but could not reach the swash channel. This rate of firing cannot even be approached by the rifled guns, while there is nothing in the shape of a torpedo-thrower that can possibly be compared with this performance.

The acceptance tests also included an examination into the time required for the mechanical operation of the guns, such as elevating, depressing, and traversing. The guns can be operated by hand or by electric motors. The latter will carry them through 360° in $48\frac{3}{5}$ seconds for the 15-in. guns, and 1 minute $25\frac{1}{4}$ seconds for the 8-in. guns, while the same work can be done by hand in 8 minutes 11 seconds and 5 minutes 56 seconds respectively. The electric motor will elevate the 8-in gun from 0° to 35° in 14 seconds and depress it in 15 seconds; the elevation and depression of the 15-in. gun to $34\frac{1}{2}$° in $8\frac{1}{5}$ seconds and $9\frac{1}{2}$ seconds; hand-power requiring 45 seconds and 48 seconds for the 8-in. and $26\frac{3}{5}$ seconds and 26 seconds respectively.

One of the prime elements in the success of a dynamite gun is to have a suitable fuse. In regard to this we can only say at this time that out of all the shots fired—and there were 38 official and 8 extra for the company's exhibition—only two failed to explode on impact, and some were fired at the close range of 100 yds. In a future issue we will illustrate this fuse and then give a further account of its action in these tests.

The trials demonstrated that this battery has exceeded the demands of the specifications in almost every particular, and it has therefore been accepted by the Government. The company are now at work upon the battery that is to be located in the harbor of San Francisco, thus giving to the main Atlantic and Pacific harbors of the United States the most efficient type of torpedo throwing battery.

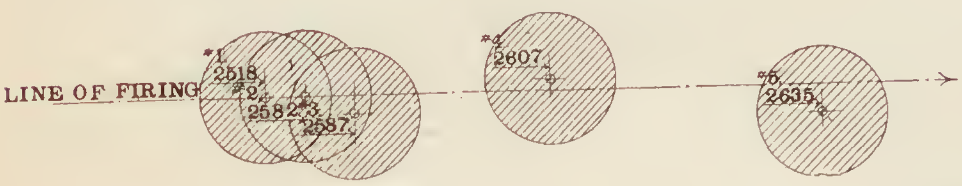


Fig. 3.

Plotting of Shots from 8-in. Pneumatic Dynamite Gun with 100 lbs. of Explosive.

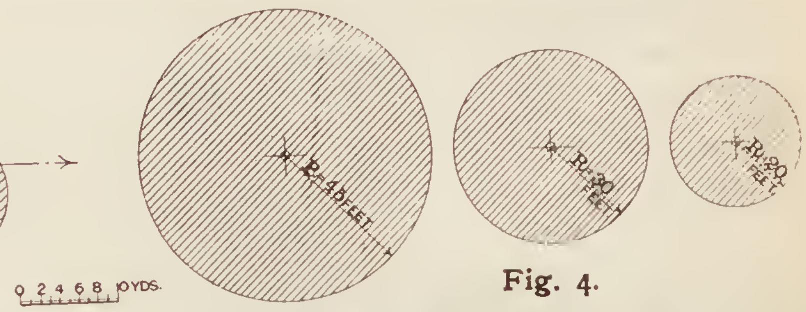


Fig. 4.

15-in. Full Calibre Projectile with 500 lbs. of High Explosive. 10-in. Sub-Calibre Projectile with 200 lbs. of High Explosive. 8-in. Projectile with 100 lbs. of High Explosive.

ZONES OF DANGER TO FIRST-CLASS ARMORED VESSEL, BY FORMULA OF GEN. ABBOT.

* Owing to a mistake in the drawing room, the distance of shot No. 1 should be 2578 yds. instead of 2518 yds. as marked. The scale of the plotting is correct.

THE HEILMANN LOCOMOTIVE.

At a recent meeting of the American Institute of Electrical Engineers, Mr. H. Ward Leonard read a paper on Recent Electrical Engineering Developments in France and England, in the course of which he referred to the Heilmann locomotive. As his remarks and opinions on this subject are interesting, and may, perhaps, be taken to represent the position of the promoters of this electrical locomotive, we reproduce that portion of his paper in full:

"In France I examined what I considered the most important electrical engineering development of all that I saw. It was the Heilmann electric locomotive. Having been for some years past a firm believer in the merit of this machine, and having been in correspondence with Mr. Brown, Mr. Heilmann's electrical engineer, as to an invention of mine used in this locomotive for the first time on a large scale, I was especially interested in it, and my hearers will please discount as they may think necessary my description of the advantages of a locomotive using my system of control.

"The locomotive I saw was the first one built, and was not in service when I was there. It had run 2,200 miles commercially, however, and as a result of the performance of this first locomotive, which was 600 H.P., there are now building two locomotives of 1,500 H.P. each, which it is expected will go into commercial service about June next.

"This electric locomotive carries its own central station with it. It is really a complete central station on wheels, with its power used for propelling itself. Speaking from memory, I should say the length over all was about 50 ft. The locomotive is mounted upon two bogies each having four axles, so that the weight of the locomotive is borne by 16 wheels, each of which is about 45 in. in diameter. A platform made of heavy iron girders runs the whole length of the locomotive, and is supported upon two pivots, one at the centre of each bogie. Upon this platform is mounted the coal, water, boiler, engine, dynamo, etc., so that it will be noticed every pound of material is used upon the drivers, and therefore becomes effective for tractive purposes.

"The entire weight of the locomotive is 114 long tons—that is, about 15,500 lbs. per driving-wheel, which is about the same as our standard practice in this country. With a tractive coefficient of .2 this means a draw-bar pull of 50,000 lbs., and assuming friction at 6 lbs. per ton, we find that 50,000 draw-bar pull would enable us to pull 1,900 tons on a 1-per cent. grade at a low speed, say 15 miles per hour, and would give us ample draw-bar pull for handling a 200-ton train at any speed thus far seriously discussed.

"Most engineers who have heard of the Heilmann locomotive have derisively dismissed it from their minds as a ridiculous monstrosity of a crazy Frenchman; but I have for some time believed, and am now convinced, that you will in the immediate future be bound to give this machine the most respectful consideration. I find that the impression prevails generally that the modern steam locomotive is really a very perfect and efficient machine. This I think is far from being true. The efficiency of a boiler depends largely upon how perfect the combustion is, and with forced draft we can realize an efficiency of 80 per cent. with very perfectly designed boilers, provided we do not attempt to burn more than about 40 lbs. of coal per square foot of grate surface per hour. But the

maximum duty of boilers in locomotive practice such as for the highest speed service involves the use of nearly 200 lbs. of coal per square foot of grate surface, and I need hardly say that forcing the boiler in this way results in a terrible inefficiency. To produce an I.H.P. in a steam locomotive at highest speeds to-day probably requires at least twice as much coal as is required in first-class stationary or marine boilers. This is the first place where Mr. Heilmann is able to show an economy; he is able to carry a larger boiler, and hence does not have to crowd it to such a wasteful point.

"But regardless of an abundant supply of steam from the boiler we find ourselves greatly limited in power for steam locomotive practice at high speed, because of the wire-drawing of the steam and difficulty of properly exhausting when we run our locomotive at its highest speed. The maximum draw-bar pull obtainable when running at the highest speed is only about half that obtainable at slow speed, no matter how much steam we have at command or at what cut-off we work. Heilmann avoids this difficulty, as we shall see presently.

"Another matter of most serious importance is the tremendously destructive effect upon the road-bed and upon the locomotive itself, of the unbalanced vertical component of the motion of the counterbalance weight of the steam locomotive, and also the shouldering effect of the locomotive tending to spread the rails. Probably at least one-third of the cost of maintenance of the road-bed and the locomotive for high speed service could be traced directly to this destructive hammer blow and side thrust. Both of these effects, which become very troublesome as we go to the higher speeds, are entirely absent in the electric locomotive.

"Having now pointed out the weaknesses of the steam locomotive, which develop most forcibly as we increase in speed, I will describe the construction of the Heilmann locomotive and point out how those difficulties are obviated by the electric locomotive.

"The steam engine is compound, well balanced, and directly coupled on its shaft is the electric generator. A four-pole single reduction motor of the iron-clad type is geared to each of the eight axles, and the motors, which are series wound, are multiple with each other across the brushes of the generator armature. As the motor field must have a fair degree of saturation to prevent sparking when the locomotive is running light and pulling no train, it will be evident that under all operating conditions the motor fields are constant and fully saturated, which makes them entirely sparkless. The field of the generator is separately excited by means of a small auxiliary engine and constant potential dynamo, which also supplies the electric lights needed. The engine has a fixed cut-off at the most economical point, say one-quarter stroke, and its speed is adjusted by the throttle.

"The engine in practice is varied in speed from perhaps 50 to 500 revolutions, and the strength of the generator field from zero to its maximum strength. It will be noticed that all steam used is used expansively at a fixed cut-off, and Mr. Heilmann lays great stress on this, although I myself would prefer an automatic engine running at a constant speed, and I believe that he would, if he could get as good ones abroad as we can in this country. For starting, an almost unlimited torque is secured by gradually increasing the generator field strength and speed, which sends a current through the motors, rising smoothly from zero to that current sufficient to start the motor armature. If we leave the field controller and throttle in this initial position, our train will start smoothly, and will continue to move slowly, using the full current, but producing the current with about 50 volts or one-tenth of the full voltage, and we will be producing this power, about one-tenth of that required at full speed, by a steam engine using steam expansively instead of, as in the steam locomotive, full stroke. But of course we desire to accelerate the train rapidly, so we keep on manipulating the field controller and throttle, until we finally have the engine driving the generator at full speed in a field of full strength, which will of course represent the full power of the locomotive. When we reach a grade requiring three times the torque required on the level, we weaken the field to one-third of its full strength. We will then move up the grade at about one-third of the speed on the level while using the same power as was required on the level.

"It will be noticed that under the electrical arrangement on this locomotive, the electric energy is used in such a manner that its voltage is varied in proportion to the speed desired, and the amperes are in proportion to the torque required, so that the electrical energy produced is utilized in the most efficient manner possible.

"Since this method of control of mine has been repeatedly criticised before this Institute on the score that a generator of such size and type when used as described would spark disastrously, I beg leave to say that I scrutinized most carefully the commutator of the generator which had supplied the current during the locomotive's 2,200 miles service, and I never saw a commutator and brushes in more perfect condition, and the engineer assured me that under no circumstances had there been any sparking whatever. I regret that my method of control does not fit the generally accepted self-induction theory of sparking, but am forced to conclude that as something is evidently wrong, it must be the theory, which fails to agree with the facts.

"An electric locomotive of this kind would probably cost for the first few about $30,000, each being equipped with a 1,500-H.P. boiler of our best marine type, and one of our best automatic cut-off compound engines directly coupled to a modern multipolar generator. I believe that a locomotive of this type could be built which would be able to pull 50 per cent. more weight than any of the present steam locomotives, and that it could pull the same weight at 50 per cent. higher speed. I think this type of electric locomotive is the stepping stone between the steam locomotive and the electric locomotive operated from a distant central station.

"To properly try the experiment of operating a high-speed locomotive of 1,500 H.P. from a central station would undoubtedly cost nearly a million dollars. To try it with a locomotive of the Heilmann type would cost not more than $50,000, and if it proves successful, it is not much of a step to replace the boiler and constant speed steam engine with the moving contact and constant-speed electric motor for driving the generator already tested and proven satisfactory."

YARD ARRANGEMENTS ALONG HEAVY-TRAFFIC HIGH-SPEED RAILROADS.*

By A. Flamache.

(*Continued from page* 113.)

INTERMEDIATE STATIONS.

The service that must be assured may be included under four heads: 1. The standing of trains at the station. 2. The side-tracking of slow trains. 3. The reception and storing of freight cars. 4. The passing from one track to another.

Since there is no headhouse and a direct entrance, it is necessary that freight and passenger trains should stand on the main tracks at intermediate stations. The thing to be aimed at, then, is to cut the time thus occupied down to the lowest possible limit. For passenger trains, the length of the stop depends, for the most part, on the time required for getting the passengers in and out of the cars; and this can be considerably lessened by having a suitable arrangement of platforms. The use of elevated platforms that have sufficient length and which give free access to the cars without necessitating the performance of feats in gymnastics, where a single unskilful performer will occasion considerable delay is, I believe, the best way in which to attain this object.

The addition of sheds affording a comfortable shelter, which will attract passengers to the platform, instead of remaining in the waiting-rooms, and the use of bridges and underground passageways permitting the tracks to be crossed in safety at all times, will also contribute very materially to the rapid and efficacious performance of station duties. To these measures for the promotion of the efficacy of the service, others may be added that do not really belong to the subject that we are considering, but which may be enumerated to advantage. The doing away with the immense suburban trains and substituting for them a greater number of short, light trains with a large seating capacity, the use of powerful locomotives that can start the train quickly, quick-acting brakes that will bring the train gently to a stop, cars with separate compartments having easily opened doors which can be operated from the inside, a *personnel* that is active and attentive to business, and finally a public that is drilled into the recognition of the value of time, are the measures that would cause the blocking of main lines by slow passenger trains to almost entirely disappear.

Freight trains that stop at a station to take on or set off cars sometimes stand there for a long time. Side-tracking by backing in is so slow an operation that it cannot be counted upon to free the main line. It is necessary, then, to encroach upon the local tracks in order to lessen the time of standing.

* Bulletin de la Commission Internationale du Congrès des Chemins de fer.

However scanty the local traffic may be, and however short the period of the year during which it lasts, it is always well to treat the freight yard liberally. Do not block it up with cars that must be pushed out to give place, do not run down the tracks for an unnecessary distance, are some of the general instructions that it is well to give.

If the standing of a train is due to the occupation of the following block, it will be necessary to examine into the causes and to do away with them if possible. If this cannot

FIG. 2.

FIG. 3.

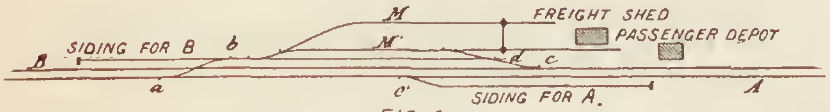


FIG 4.

be done, then it will be well to cut the succeeding block in two, which will facilitate the starting of the second train. Or, in certain difficult cases, one may even be led to urge the doubling of the tracks for a certain distance.

Side-tracking of Slow Trains.—This side-tracking is often made on a single track for both directions. The arrangement in actual use at the intermediate stations of the Belgian State Railway (fig. 5) is laid out in this way. The great disadvantage of this plan lies in the fact that a train arriving by the track *A* is compelled to cross the track *B* at *T*, which naturally involves the stopping of traffic on that line (fig. 2). If the sidings are doubled, as shown in fig. 3, this disadvantage is entirely done away with; a crossing being avoided, there is a saving in signal apparatus. Finally, the two switches *c* and *c'* are not necessarily at fixed distances from each other, the expense over the arrangement shown in fig. 2; but these sidings that are used but little can be laid with material that is worn out, simply keeping the first few yards that are used by passenger trains in good condition. They can end in a simple buffer made of old ties.

The Loading and Unloading of Freight Cars require that there shall be suitable platforms along the tracks, long approachable tracks, and various appurtenances, such as cranes, etc. The whole may be embraced under the comprehensive term of the "freight yard." It is most frequently placed on one side of the main tracks. It is only under rare local conditions that it is possible to give each line of rails its own yard.

The length of the freight yard is determined by the importance of the local traffic, and this with the necessary adjuncts should not be made too long. It is better to lay a greater number of tracks for the little extra ground that they will occupy. At any rate, it is well to acquire all of the ground that will be demanded in order to make the extensions that may be called for.

A freight yard frequently consists of two tracks that are parallel or slightly divergent, running into the main lines at two points. It is a common thing to connect them by several batteries of turn-tables. This latter adjunct is usually expensive, cumbersome, and is of no great use.

The arrangement of stations frequently adopted on the Belgian State Railway is shown in fig. 5; it is very good, with the exception of the addition of the two turn-tables, which could be done away with, if we reserve track *M* for the use of the line *A*, and the track *M'* for that of *B* (fig. 4). Fig. 4 shows how, in case of a double siding, the connection *c d*, which leads off to the siding for *B*, also connects with the freight track for the same line. At the same time, the arrangements of the two connections *c d* and *a b* permit of the passage from one main track to the other in case of an accidental obstruction. The arrangement shown in fig. 6, which is on the scale of $\frac{1}{4000}$, is a very convenient one. It is the one that requires the fewest changes in the track, and has only one crossing on the main line. The switches *c c'* can be placed near the freight depot, and the sidings lengthened at will. In many

FIG. 5. PLAN OF INTERMEDIATE STATIONS ON THE BELGIAN STATE RAILWAY

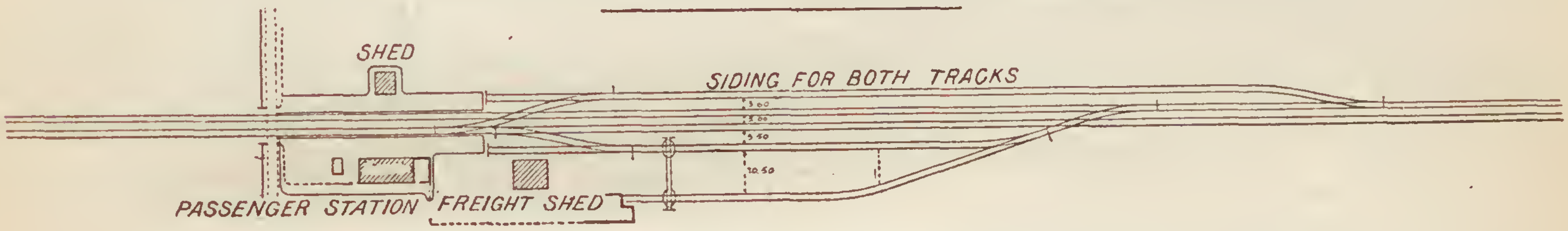


FIG. 6 PROPOSED PLAN OF INTERMEDIAT STATION FOR A MAIN LINE

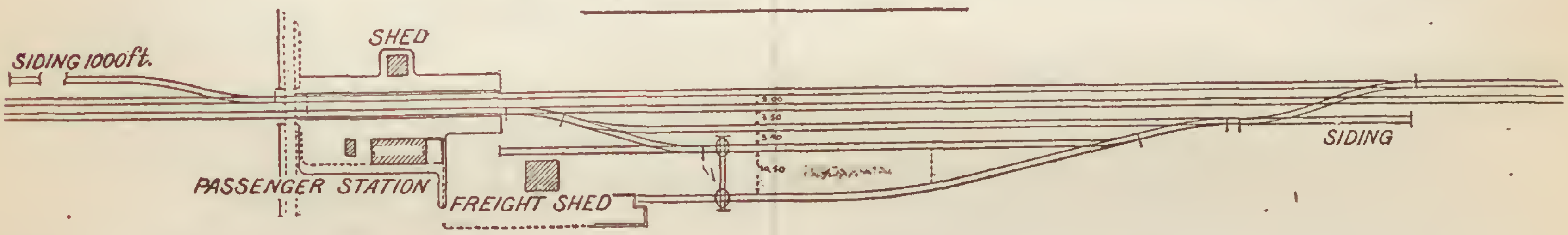
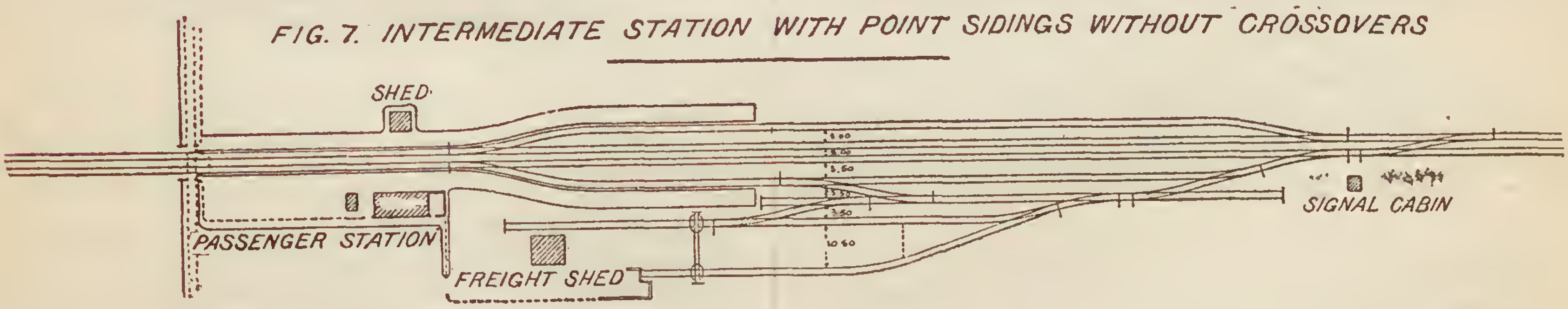


FIG. 7. INTERMEDIATE STATION WITH POINT SIDINGS WITHOUT CROSSOVERS



which will give some advantage from the standpoint of service and safety. Thus there is an advantage in placing them as near as possible to the receiving depot, in order that the station master may be in a position to know that the train to be side-tracked has passed upon the siding so far that it does not obstruct the main line. By placing the signal levers near at hand the station master can assure himself, at a glance, that everything is all right.

In order to secure perfect protection, the length of each siding should be at least from 15 to 20 per cent. longer than the longest train that runs over the road, which will double cases, however, as we shall see later on, it is impossible to obtain this simplicity, and it is necessary to have separate switches for the yard and the depot tracks. We often find, at some intermediate stations, that there is a direct connection between the two main lines. This arrangement, which is common in England, permits the switching of a train from one track off on to the other; it is very advantageous at times, but can only be justified when the tracks are overburdened. Under other circumstances these direct connections simply serve to facilitate the passing from one track to the other in case the traffic is accidentally blocked. Now, it is not reason-

able to establish a cause of permanent danger in order to facilitate a possible movement. It is, therefore, best to do away with all connections of this kind that can be avoided.

General Arrangement of Intermediate Stations.—An examination of the various arrangements that can be employed at intermediate stations, without running counter to the foregoing recommendations, shows that there is a marked advantage in placing the yard at the right of the freight depot when the trains take the left-hand track. Therefore fig. 6 appears to me to be a plan that is to be recommended, in that it serves as a general type where a single yard is made to accommodate the trains running in both directions. It has the following advantages:

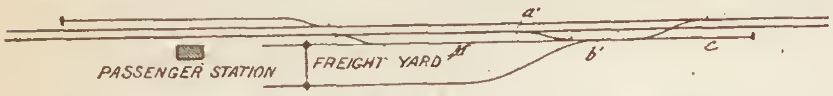


FIG. 8.

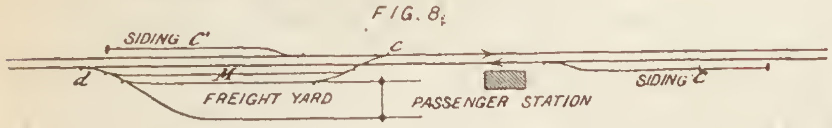


FIG. 9.

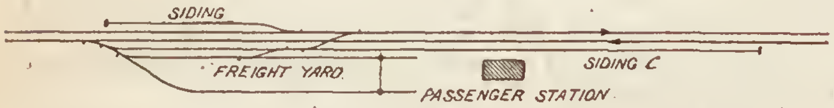


FIG. 10.

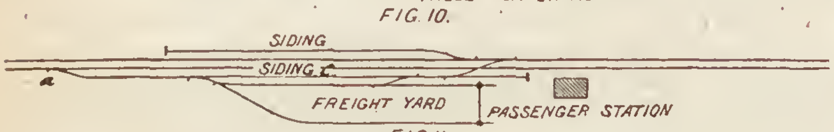


FIG. 11.

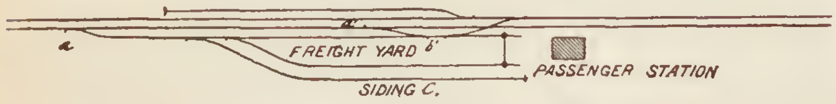


FIG. 12.

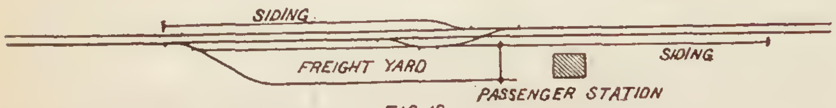


FIG. 13.

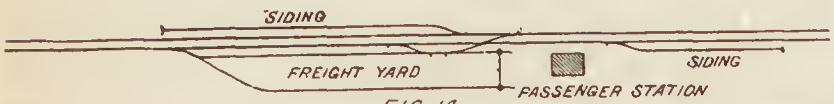


FIG. 14.

1. It has the smallest number of signals and switches on the main line with the one unavoidable crossing.

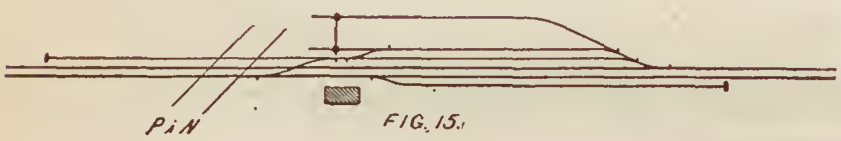


FIG. 15.

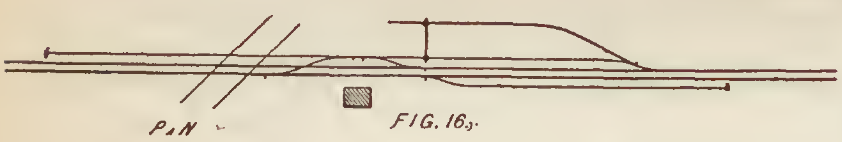


FIG. 16.

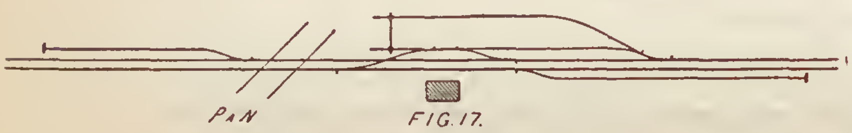


FIG. 17.

2. The switches are near the receiving depot, and the length of the sidings can be increased at will.

But as this type cannot always be realized, it will not be amiss to give plans of other arrangements that are nearly as good. It frequently happens, especially if the freight yard is

FIG. 18

already in existence, that the passing siding of figs. 4 and 6 cannot be located between it and the main tracks. The siding *C* therefore is made to be approximately a prolongation of the first track in the yard. It then becomes necessary to put in a supplementary siding, *a' b'*, in order to gain access to the siding *C*, and to pass from one track to the other without disturbing the cars that are stored on the siding *M* (fig. 8).

When the freight yard is placed at the left of the depot, the arrangement becomes similar to that shown in fig. 9. It has one more crossing on the main line. It is well to put in a free track, *M*, between the yard proper and these latter, in order to be able to pass by the switches *c* and *d*, from one track to the other, without disturbing the cars that may be stored on the inside tracks. In some cases the track *M* can be connected to the siding beyond the receiving depot, which will do away with the supplementary crossing (fig. 10). This can also be done by placing the whole siding to the left of the depot, as shown in figs. 11 and 12; but these two arrangements increase, over that shown in fig. 10, the disadvantage of removing the switch *a* to a distance from the direct supervision of the station master. Thus the plan of fig. 13 is to be preferred, although it has a supplementary cross-over. For the same reason the plan of fig. 14 is better than that of fig. 10, although it has the same defect as fig. 13.

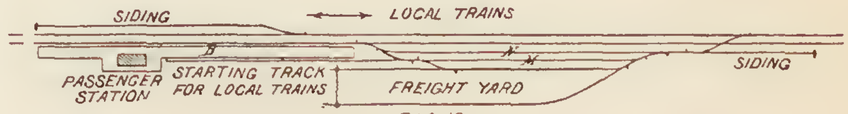


FIG. 19.

FIG. 20.

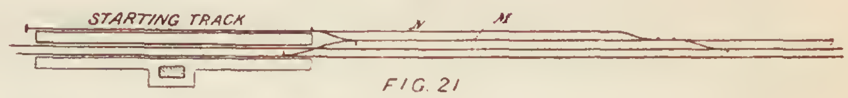


FIG. 21

We have heretofore supposed that the yard is located next to the depot. Although this is common, it is by no means universal. But everything that has been said may be repeated for the arrangements in question. The three figs. 15, 16, and 17 present examples of this type.

Intermediate Stations with Factory Sidings.—If all of the factory sidings are upon one and the same side of the main line, there is usually an advantage in placing the freight yard upon the same side; but if it is not possible to do this, it is necessary that the crossing of the main line by cars pushed by hand or hauled by horses should be avoided. The method to be followed in this case is to connect these factory sidings with one or more tracks *M*, that in turn connects with the main siding on this side, and which thus gives a direct connection to these tracks (fig. 18).

Intermediate Stations with Terminus for Local Trains.—At intermediate stations where there are no point switches at

FIG. 22.

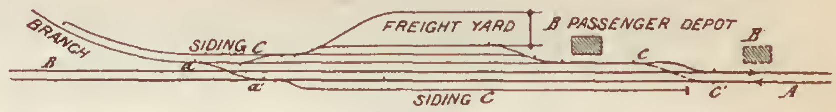


FIG. 23.

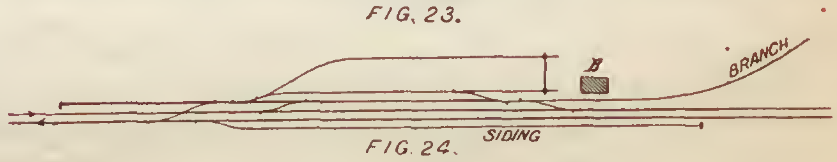


FIG. 24.

the place where local trains must branch off, the arrangements of such stations must be examined in addition to those already discussed:

1. Pains must be taken to free the main line from the unloaded train as quickly as possible.

2. There should be a special starting track that will require no changes in the points when running out.

3. The location of the tracks that are used for the shunting of the engine, in bringing it from one end of the train to the other, turning it, etc., should be such that they do not interfere with the main lines.

These different desiderata can be easily obtained if we place the special starting track on the side of the incoming track of the main line. The two arrangements, shown in figs. 19 and 20, seem to be about the best that can be designed.

On its arrival the local train stops on the main line and discharges its passengers. The engine then immediately backs the train of cars upon the siding *M*, cuts loose and shunts around to the other end by way of the track *N*, and then pushes the train upon the starting track (fig. 19). This

discussion might be prolonged almost indefinitely, but we merely give one other sample of what may be done in fig. 21.

Intermediate Stations with Direct Sidings.—When there are two yards with point switches and sidings into which a train can run without stopping, and they are some distance apart, it may occur that it will be convenient to sidetrack a train at the station that lies between them. As the side-tracking of a train by backing in requires some time to execute, it is some-

FIG. 25.

FIG. 26.

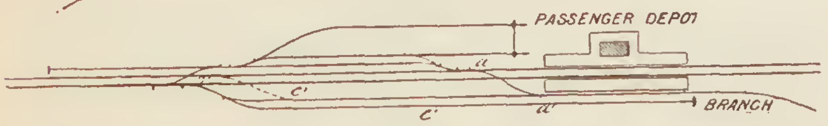


FIG. 27.

times an advantage to allow the train to run slowly and then side-track at the next important station. There is then a great advantage in locating an intermediate station about half-way between the two with point switches allowing trains to run in direct. According to the circumstances of the case, it may be well to either lay four tracks or a third track between the other two.

Direct sidings involve the necessity of having two signal stations for the protection of the lines in each direction. One set of signals can, however, be made to suffice if we take the precaution to locate one end of the siding near the depot, so that all entering trains are under the immediate supervision of the men who are responsible for their safety. This end may then be cut off from the interlocking apparatus.

Thus, while the arrangements of the intermediate station must not differ essentially from the current practice, this use of head-on sidings does possess some advantages that cannot be neglected, and these are :

1. Trains taking on or dropping cars can stand on the sidings and not obstruct the main line in the slightest.

station. The service at such stations, therefore, does not differ from other intermediate stations, and the arrangement of the tracks only differs in that the presence of a junction permits of a location that will be more advantageous to the service. In order to get the advantage of this it is essential that the junction should be within the yard and not at one end of it. The Belgian disposition, which consists of placing the yard upon a common trunk, is not recommended (fig. 22).

In order to obtain a rational arrangement, it is necessary that two cases should be clearly distinguished : 1. That the

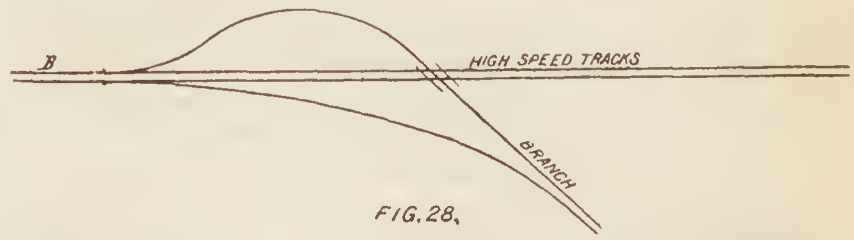


FIG. 28.

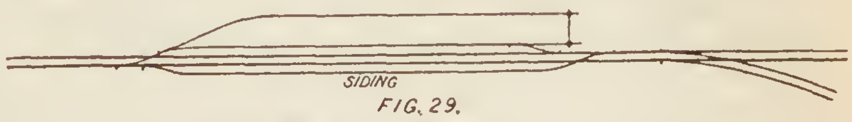


FIG. 29.

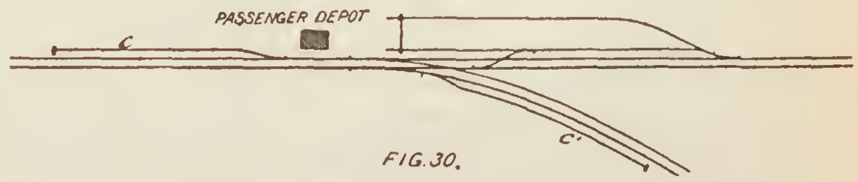


FIG. 30.

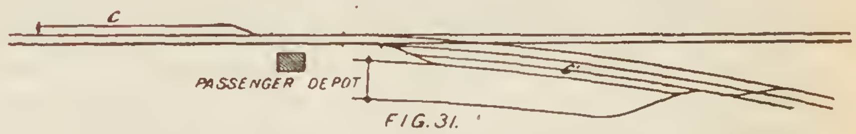


FIG. 31.

branch, which is usually of a single track, is only of slight importance. 2. That the branch has a service similar to that of the main line.

In the first case there is an advantage in placing the freight yard at one side of the junction, as shown in fig. 23. The switching of trains from the track *B* is made upon the siding *C'*, but in many cases this can be done away with and the branch itself be used. It is best to locate the station building just ahead of the junction, so that trains coming from the

JUNCTION STATION WITH UNDERGROUND PASSAGE

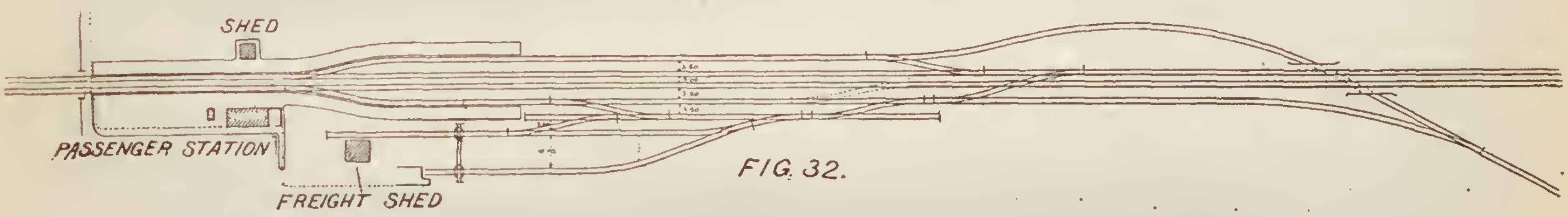


FIG. 32.

JUNCTION STATION WITH UNDERGROUND PASSAGE

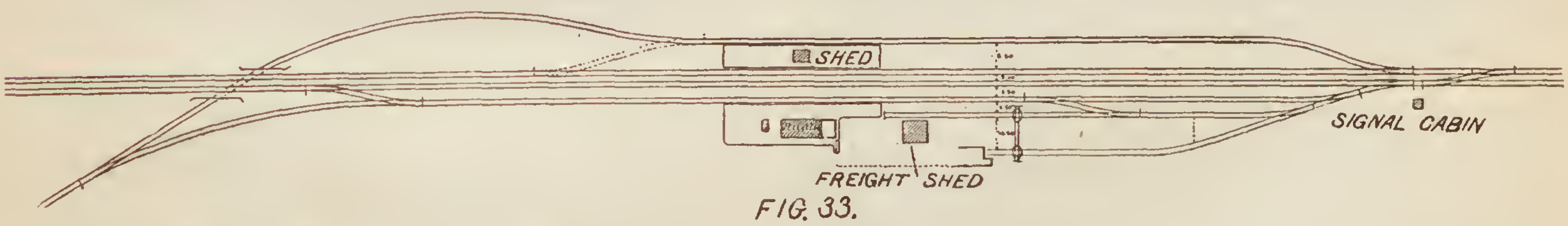


FIG. 33.

2. The head on siding can be used to great advantage by passenger trains that have to go on the side-track to allow a faster train to pass.

3. A main line crossing can be avoided and a better connection substituted therefore by establishing means of communication between the two main lines.

Fig. 5 gives the scheme of a station in which these advantages are realized.

Intermediate Stations with Junctions.—Stations of this kind are those where a branch line comes in to make a connection with the main line, but without there being of necessity facilities for the change of cars by the passengers or handling of freight or cars for transhipment. Oftentimes the trains pass without stopping, the change being made at a more important

branch do not obstruct the main line while standing there ; but if the branch is of comparatively little importance, there is no harm in locating the building at *B'*. It is also possible to avoid the standing of trains that are to run in on the branch on the main lines by placing the switches *a a'* at *c c'*. If the freight yard must be placed on the opposite side of the tracks from the station building, the arrangement becomes similar to that shown in fig. 24.

In the two types that have just been shown the branch is located on the same side of the main line as the station building and the local tracks. If this is not the case the connections become a trifle more complicated, but the service is none the less easy. Examples are given in figs. 25, 26, and 27.

It will be remarked that when the branch starts off to the

left of the main line it affords a means of running direct into a siding in the divergent direction, that is when the trains run on the left-hand track. This is shown in figs. 24, 25, and 26. It would be possible to obtain the same advantage when the branch runs off to the right, as shown in fig. 27, by carrying the switches $a\ a'$ to $c\ c'$, but this switching off to the right would involve the crossing of the main line, which might block it at an inopportune moment; and is one of the causes of danger that materially lessens the advantages of a head-on siding. If these latter are considerable, it will be well to look into the matter and see whether a switch running off to the left would not be preferable. It may be mentioned in passing that it is always possible to carry the branch off to the left by the use of a bridge, as shown in fig. 28.

The advantages of this arrangement are quite evident, and its adoption should only be abandoned for imperative local circumstances or for reasons of economy.

Figs. 32 and 33 show some arrangements that give good results where underground passages are used for the clearing of the main lines. If the two lines at the junction are at all comparable, these plans do not apply, for it is necessary to adhere to the most easily located junction connections.

It is a mistake to locate the place of the local installations upon a single trunk, as is usually done in Belgium, and which is shown in fig. 29. By comparing the plan of fig. 29 with that of fig. 30, the superiority of the latter will be easily seen, and that fig. 31 is better than either.

The side-tracking of diverging trains is done on the main line; that of converging trains on the siding at the right. For the purpose of securing equal facility of service, the freight yard is so placed that it is traversed by but one of the branches, so that the number of signals and the danger of collision are reduced to a minimum. The sidings c and c' can be done away with by switching the trains running in one direction upon the opposite branch both in the diverging and converging service; but this is only to be advised in the cases that have been supposed—namely, a heavy traffic in both directions. Finally, in some cases a better arrangement than either can be obtained by placing the station in between the two branches and using the cross-over of the junction for the freight yard. The station building should be placed in the angle of the two lines, but it can be kept upon the common trunk if the local service is not too great.

(TO BE CONCLUDED.)

THE ELECTRIC MOTOR IN A BOILER SHOP.

The interest that was taken in the February discussion of the Mechanical Engineers on the Electric Motor in the Machine Shop is sufficient to show that the subject is attracting a great deal of attention, while the actual data available on the subject are very meagre, even the motor builders themselves being unable to state definitely as to just what results from the standpoint of economy can be expected from this or that method of installation. Despite these drawbacks, however, there is a well-established idea pervading the community of mechanical engineers that the electric motor readily lends itself to the driving of machine tools, and its application is rapidly growing.

A short time ago the Cornell Steamboat Company, of Rondout, N. Y., decided to build a new boiler-shop for the repair work on their large fleet of boats. After a careful investigation of the subject, the Chief Engineer, Mr. Thomas Coykendal, decided to use electric motors, making an individual application to each machine. Though one large company recommended the use of one large motor having sufficient power to drive the whole shop through a line or lines of shafting, very much in harmony with the trend of the general recommendations at the February meeting, this was considered to be in no way superior to the use of an engine, and was discarded. The engraving shows the application of a 2½-H.P. motor to the driving of a small drill and emery wheel, which is the only case where one motor drives more than a single tool, and a 5-H.P. motor driving a shears. The smaller motor makes 950 revolutions per minute and the larger 650 revolutions, the speed being reduced by means of counter shafting, as shown, with two exceptions: a combined punch and shears is driven by gearing direct from the motor, and a 7½-H.P. motor is coupled direct to the shaft of the blower for the furnaces and forges. The complete equipment of the shop consists of one 2½-H.P. motor driving a drill press and emery wheel; one 7½-H.P. motor driving blower; one 2½-H.P. motor driving large drill press; one 5-H.P. motor driving horizontal punch; one 5-H.P. motor driving shears; one 5-H.P. motor driving combined punch and shears, making a total of 27½ H.P. capable of being called into action, or, speaking more accurately, 25 H.P., as the blower only requires 5 H.P. for its operation instead of the 7½ H.P. at which it is rated. It is the intention to put an electric travelling crane into the shop at an early date.

Of the convenience of the arrangement both Mr. Coykendal and Mr. Belcher speak in the highest terms. The tools are always ready for action; though the men may all be out of the shop and at work on board boats, if a hole is to be punched or a piece of iron to be cut, it is simply necessary for a man to go to the shop, start the motor, do his work, shut off the current, and leave matters as he found them. By doing away with shafting and bolting the motors to brackets on the walls, the whole floor space is left free and clear, so that the travelling crane, when it is put in, will have an effective travel nearly from wall to wall, and covering every machine in the shop. Then, as the machines can be arranged independently of each other along the walls, the whole of the central floor space is available for erecting purposes.

But, as these advantages are apparent to all, it remains to ascertain what may be the cost of operating such a plant. The current is obtained direct from the power-house of a street railway company that stands at a distance of 1,650 ft. There is no reduction in the voltage, which is 535; and the Crocker-Wheeler motors are used. This voltage, it will be seen, is very much higher than that recommended by Professor Crocker in February, but is used in order to simplify the installation and the handling of the current. It is estimated that the 7½-H.P. nominal or 5-H.P. actual motor that drives the blower, and the 2½-H.P. motor driving the drill and emery wheel, will be run continuously for 10 hours a day, and that the remainder of the machines are working on an average total of 2½ H.P. per hour for 10 hours a day, making a grand total of 10 H.P. continuous working. This is an estimate, and one not reached by actual metre measurement, but is that upon which the estimate of the cost is based, which is put at $50 per calendar month.

This is a definite statement of cost, and is seemingly satisfactory. While it appears probable to an outsider that the cost of producing 10 H.P. in a boiler-shop, where the services of the engineer could be utilized in work about the shop, might be made to fall below $600 a year, it is hardly probable that that amount could be made to cover the 25 H.P. which would have to be kept on tap, as it were, all of the time, and certainly could not if the engineer became an engineer and nothing else; and any one who has tried it knows how unsatisfactory it is to attempt to utilize the spare moments of an engineer about a shop; and when we compare the dirt and trouble of an engine, the space occupied by shafting, with the convenience of operating, and the bright daylight that is made possible by the perfect freedom from all overhead obstructions, it is very evident that the Cornell Steamboat Company did well in adopting the electric motor for its boiler-shop.

While dealing with this subject, it will be in order to quote from a letter received by Mr. Richmond from M. Melotte, after the presentation of his paper on the Electric Motor in the Machine Shop. This letter is a hearty endorsement of the application of electric motors which we are considering, and is valuable in that it emanates from one who has had a practical experience in this very matter. After referring to a paper by M. Castermans and himself that was published in the *Revue Universelle des Mines*, M. Melotte wrote:

"Since the time of writing that description the shop has been enlarged, and we have been forced, in the first place, to add a Willans engine driving directly a dynamo at 350 revolutions, 300 I.H.P. At the present time we are constructing for the same factory a third dynamo which will be operated by a Willans engine of 360 H.P., indicated at 350 revolutions, which will result in giving to the shops 5,600 ampères at about 125 volts, instead of 2,400, as provided for in the first instance. The reason of this increase lies not only in the enlargement of the factory, but more particularly in the increase of useful work furnished by the workmen operating the machine tools.

"In fact, at the outset the workmen were to produce 150 pieces of each of the constituent parts of the gun. Paying them at piece rate so stimulated their ardor that they succeeded in producing 300 pieces every day—that is to say, doubling the production.

"Thus it comes that the motors are found too small; and here I may make a little digression.

"According to the instructions of the builders of the machine tools, these latter were arranged to have about 12 effective H.P. on each shaft of transmission. As a precaution we had placed electric motors of 16 B.H.P., but it was found a short time after getting to work that these motors were developing 30 H.P. I cite these figures at this time, although only motor No. 5 was in this condition; but a short time afterward

several others came to it, and one could see for four months these motors of 100 ampères working with charges varying from 200 to 300 ampères. You can imagine that they got warm and that they sparked, but they worked nevertheless. At this time several people not initiated in electric science called in question the work done by the motors, saying that the motors only gave out 10 H.P., while we declared that they were doing 30 H.P. We were obliged to make experiments with the brake to convince them. It was then decided to put more motors in, but as the shafts were very long, and had not been provided for this load, it was decided to cut them in the middle and place a motor at each end. We left in place the 16-H.P. motor; at the other end we placed a motor of 35 H.P. This has been done with three or four shafts; for other shafts we were content to replace the 16 H.P. motors with others of 25 H.P. or 30 H.P. Finally, quite recently the factory has enlarged its cartridge room, which necessitates the new motors. I have made this long digression in order to explain to you why the original provision of 2,400 ampères has had to be replaced by 5,600. I have omitted to mention the extension of the electric lighting, which has absorbed from 300 to 400 ampères.

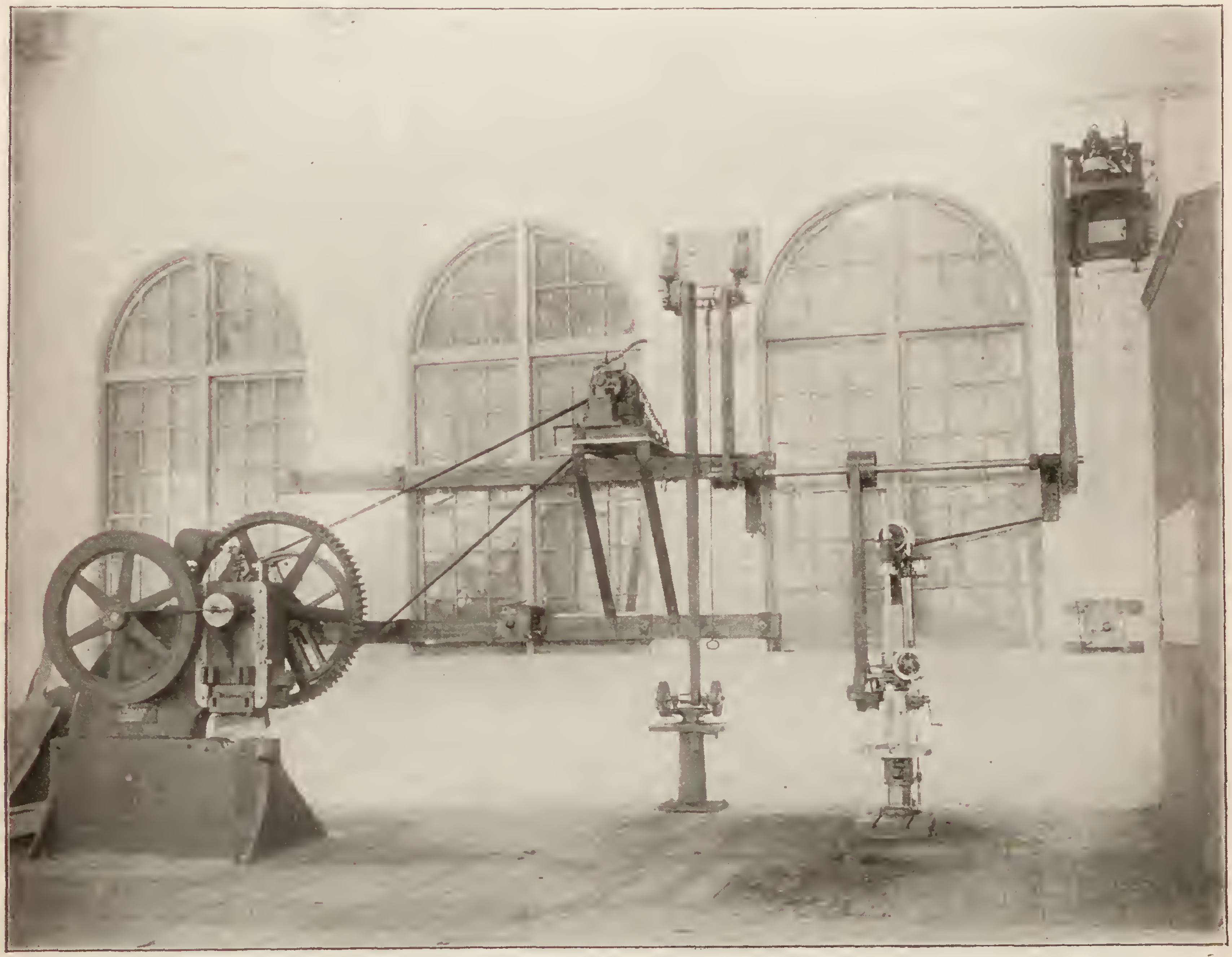
"All that I have just said to you serves to explain the extraordinary elasticity of transmission of force by electricity. You see in what a difficult situation the gun factory would have been if, instead of this mode of transmission, it had adopted mechanical transmission. The difficulty of increasing the transmitted power would have been enormous, and it would have been necessary to remodel the whole. The first difficulty would have been to have had the transmission shaft capable of transmitting the increase of power. It would have probably been necessary to replace them with others proportionate to the work. This difficulty overcome, it would then have been necessary to transmit to them this work right from the engine-room; while with electricity, a piece of wire and a motor, and the whole thing is done!

"Since this installation I have had to calculate, and have constructed other dynamos of the same kind at different speeds and power, going up to 600 H.P., and those of high speed have always given the most satisfaction. Moreover, from the purchaser's point of view, they are altogether preferable, costing less and being more efficient than slow-speed dynamos. I should be in favor of these latter only for very large units—1,000 H.P. to 1,500 H.P.

"As to the direct application of motors to machine tools I would not like to commit myself, not having had sufficiently long experience of this subject.

"My opinion up to the present is that the heavy machine tools, which take 1 H.P. effective, could advantageously be operated by separate motors; but that when it is a question of small lathes or small milling machines the case is not the same. And here we must distinguish between the case where the tools have to work intermittently and where they are constantly occupied—in fact, if it is desired to put a motor to every tool, we should have to with $\frac{1}{2}$-H.P. motors, of which the efficiency is necessarily very small. If we group three or four of these machines together they could be operated by quite a small countershaft driven by a motor of about 2 H.P., from which one could get an efficiency of 70 to 75 per cent. without paying excessively for it.

"It is also necessary to judge of the probable time which the machines will work every day, and of the curve of efficiency, the different loads of the motor and of the transmission apparatus before deciding in favor of one system over another. If, for example, you have four milling machines taking $\frac{1}{2}$ H.P. each, and you could be sure of keeping them all going during the day without stopping, you need not hesitate to work them by a 2-H.P. motor and a countershaft; but if it is one of those general machines which are necessary in all shops, such as drilling machines, emery wheels, drill-grinding machines—in other words, tools which are only used from time to time—then I am convinced that a small motor, with its



TOOLS DRIVEN BY ELECTRIC MOTORS IN THE BOILER SHOP OF THE CORNELL STEAMBOAT CO., AT RONDOUT, N. Y.

wretched efficiency, even if it were as low as 40 per cent., would be preferable to no matter what system, for they use no power except when they are running, and then it gives 40 per cent., while, if you are turning a countershaft while the tool is not running, there is a loss of current, and at the end of the day your total efficiency will fall to 10 per cent., or even less.

"I think I have answered your request in going so far into detail; nevertheless, I will add a few words. All that I have just said to you refers only to shops where metal is operated on, such as machine shops. In shops for the current manufacture of some specific article the cost is approximately the same. Thus, at Herstal, where the same pieces were made over and over, it would have been possible to subdivide more than was done the distribution of power. The same is true everywhere. In textile manufactories, in the weaving room, everywhere, indeed, where it is a question of manufacturing stuffs of certain importance, the subdivision should as far as possible be made of the thread machines, looms, the 'self-acting,' etc., constituting units which can be separated in the combination."

THE MEETING OF MECHANICAL ENGINEERS.

RAPID TRANSIT IN LARGE CITIES.

THE March meeting of the New York Mechanical Engineers was held on the 13th of the month, with Mr. George S. Morrison in the chair. Mr. W. B. Parsons, the Chief Engineer of the Rapid Transit Commission, delivered the address, which was almost entirely confined to a brief historical sketch of the rapid transit problem in New York, and the means that have been taken to solve it in large cities abroad, especially London and Liverpool. As no definite plan has as yet been adopted for New York, he said nothing of the proposed system, other than that it was to be an underground route.

In the discussion some matters of interest were brought out relative to the cost of the operation of the elevated lines in New York and Brooklyn, by Mr. Nichols, Chief Engineer of the latter road. In the course of his remarks, he said:

"Perhaps the most striking illustration we have of successful railway operation in the world is that presented by the Manhattan Elevated in New York to day. In looking over some figures the other day, I was rather surprised to see how the working expenses of the London roads compare with those of the Manhattan system in New York, how favorably it compares with it, how much better the working expenses are on the English than on the American line. That may be due to the fact that their expenses for maintenance and the like are so much lighter than they are here. Recently my attention has been called to some figures as to operation, in which it was shown that the essential elements differed very radically. For instance, when we were called upon to discuss the figures by the train mile, it was shown that they varied, outrageously, one might say; and when it came to be analyzed more closely by the ton-mile, it was found that the difference was scarcely appreciable, this comparison being made not only between two prominent American elevated lines, but comparing these also with the Liverpool Overhead line, operated not by steam, as in this country, but by electricity; and, all things considered, it was rather a remarkable uniformity, I think, in the results as given by the figures. It may be interesting to give the figures for the cost of operation of the two principal lines immediately within our notice, the Manhattan Elevated in New York and the Brooklyn Elevated in Brooklyn, the former covering a mileage of about 35 miles, and the latter about 20 miles, speaking now of what is Brooklyn proper, independent of the Kings County line. It appears from these figures that, while per train-mile the operating expenses of the Manhattan Road are about 61 cents, those of the Brooklyn were 38.33 cents. Analyzing that still further, and getting it only approximately as we can by the ton-mile, it comes to this, that the cost on the Manhattan is .615 of a cent, while that in Brooklyn is .572, which is practically the same result. It may be interesting to state that the following percentages are found to be approximately correct, and I give them for the Manhattan, because they do not vary materially, except in one or two points, from the Brooklyn road. The expense of motive power, including all labor and all fuel and handling of fuel and the like, amounts to 34 per cent. of all operating expenses; the repairs to rolling stock are about 12 per cent.; the maintenance of way expenses, 10 per cent.; train expenses, 19 per cent.; station expenses, 15 per cent.; general expenses, about 11 per cent. of the total. Where the maintenance of way on the Manhattan amounts to 10 per cent. of all operating expenses, on the Brooklyn line that maintenance of way amounts to 4 per cent.; so that is the greatest difference there, excepting in motive power. Of course the motive power on the Brooklyn road, instead of being 34 per cent. of all operating expenses, is about 43 per cent."

Mr. M. N. Forney: In 1873 I had the honor to serve on a committee of the Society of Civil Engineers that investigated this subject of rapid transit, and at that time I did a great deal of work, and the committee was very much abused for what it did. However, the present elevated railroads substantially adopted the recommendations made at that time, and in fact the report which was submitted formed to a certain extent the basis of the action which they took thereafter. That report recommended an elevated railroad. We spent considerable time in the effort to arrive at some conclusion as to the probable traffic which an elevated railroad would carry. I remember using all sorts of persuasion to get from the surface railroads a statement of the number of passengers which they were carrying. Sometimes we succeeded and sometimes we did not. We then made a hypothetical calculation of what the probable earnings would be, assuming that one-third of the seats in the car would be filled, and one-half and three-quarters and some other proportions, and then assuming different rates of fare, although we were afraid to go down below five cents; and it would be quite amusing at the present time to take that report and see the extreme apprehension which was manifested by our committee, for fear that we would calculate too high the number of passengers to be carried on the railroad at that time; and probably that committee was in part responsible for the fact that the elevated railroads of the present day were built of so light a character as they are. We did not feel that we could recommend the construction of a railroad heavy enough or strong enough to carry heavy locomotives, because we did not think there would be the traffic to necessitate their use. At that time underground roads were discussed, as they have been ever since, and the conviction arrived at by myself and, I think, nearly all the other members of the committee was in favor of elevated roads; and I am still a believer in elevated roads as against underground. Of course there is the fact that the subject of underground roads has been investigated and studied very thoroughly by the ablest men in the community, and after long and mature deliberation they have come to the conclusion that the thing for New York to do is to build an underground railroad. But my own conviction is that, although it is now too late to reverse the decision of the Rapid Transit Commission, that the thing for the city of New York to have done would have been to buy the right of way for the railroad, and to have retained that right of way and give permission to a railroad company to build its road on that right of way. I have not made any very careful or thorough investigation of that matter, and therefore my opinion cannot have much weight, but my general impression is that by building the structure high enough so as to permit sufficient room to put at least two-story buildings underneath, that those buildings could be leased for a sufficient amount to pay the interest on the cost of the real estate, so that practically the city would have had the right of way free of any cost. Like my friend Mr. Cruise, I have always been in favor of an elevated road. Mr. Cruise has gone a step further, however; instead of being content with a structure underneath the elevated road, and renting that out for workshops and beer saloons and similar moral purposes, he proposes to put a structure up over this—I do not feel safe to say the number of stories; but he would build a tunnel through this structure, and run his elevated road through that. Mr. Cruise should give us his reasons for thinking that that is a practicable scheme. I am sure that I would not deny that it is, and it certainly is worthy of consideration.

The Chairman: The subject of elevated roads through blocks has been one that has been discussed a little, but it has sometimes seemed as if it had not been discussed as much as it should be. The great difficulty, apparently, in the building of a line through the blocks by a private corporation is not so much the doubt whether it will pay, as the fact that it requires an immediate outlay of capital, not only enough to build the structure, but to buy the land; and it is much easier to raise $25,000,000 with the expectation of 6 per cent. interest on it, than it is to raise $50,000,000 with the expectation of 8 per cent. interest on it. There are limits to the amount which can be raised in one lot. There is one point, however, which I think it would be well to bring out in this discussion. When the elevated railroads were first opened they charged 10 cents fare, except for a little while during the busy hours in the morning and evening. They afterward changed to 5-cent fares at all hours. The statement is made, and there is good ground for it, that the 5-cent fare pays exceedingly well as an average, but it would not pay for long-distance travel. Many of the schemes proposed for elevated railroads have been proposed for the purpose of carrying people to the upper end

of Manhattan Island and into the Annexed District. Is not one of the greatest drawbacks that we find now in getting capital to build those lines the fact that fares are limited to 5 cents ?

Mr. Parsons : It has been said that the day will come when electricity as a motive power will be more economical than steam. That day has already come. In reference to the comparative operating expenses of the Manhattan and Brooklyn elevated railroads, as compared with the three electrically operated rapid transit roads, the Liverpool Overhead, the Intramural of Chicago, and the City & South London, I have to acknowledge the kindness of the officers of those roads in giving me their figures in getting the coal consumption in pounds independent of dollars and cents. There is no use in comparing the cost of coal in London with the cost of coal in Liverpool or Chicago or New York. These five companies have given me their actual coal consumption, and I have had the figures tabulated and published. They also gave me the weights of their trains, so that, as Mr. Nichols stated, we finally have to get down to the basis of the ton-mile, and I finally reduced the question of the consumption of coal to pounds per ton per mile. These figures are given in decimals of a pound of coal consumed per ton per mile :

On the Liverpool Overhead the consumption is	.416
On the Intramural	.495
City & South London	.604
Manhattan Road (Ninth Avenue), short trains	.609
Brooklyn Elevated, short trains	.661
Manhattan on the big trains	.928
Brooklyn Elevated, big trains	.526

Analyzing the first five figures—it is really unfair to take into account the Manhattan figures at all—the Liverpool Overhead trains weigh 42 tons, the City & South London, 44 tons. Taking the Brooklyn Elevated average train as 63½ tons, we see that the coal consumed on the Liverpool Overhead is .416, and on the Brooklyn Elevated, .661. In other words, the consumption of coal in pounds per ton per mile is but two-thirds of that where they run steam locomotives. In Liverpool they burn slack of the cheapest grade that they can buy. On the Brooklyn road they burn a high-priced anthracite ; so reducing it down to the valuation put in dollars and cents, the difference would be far greater than it is when expressed in pounds. That is also regardless of the fact that the Brooklyn elevated trains weighed half as much again as the Liverpool trains, and the coal consumed per ton per mile does not increase in proportion to the weight of the train. Of course there are certain losses which are entirely independent of the weight of the train. The Brooklyn elevated train, which weighs 91½ tons, falls down to .526 and .661. The Manhattan weighs 80 tons, the coal consumption is .609, and rises to .928 ; so that we see that the coal consumption per pound per ton per mile on an electrically run road is actually less and considerably less than that on roads run by a steam locomotive.

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

The object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publications will in time indicate some of the causes of accidents of this kind, and to help lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with the information which will help make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a great favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in February, has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS IN FEBRUARY.

Marshall, Tex., February 1.—A train on the New Orleans & Pacific Railroad ran into an open switch at Waskom this morning. The engineer applied the air brakes and jumped, sustaining a severe sprain of the ankle.

Springfield, O., February 1.—George Wallace, a fireman on the Big Four, while throwing a switch this morning, was run over. His right leg was cut off, and he sustained internal injuries that may prove fatal.

Auburn, Ga., February 1.—The locomotive of a freight train on the Seaboard Air Line jumped the track near here to-day. The engineer and fireman jumped, and the latter was caught between an embankment and a wrecked car and seriously injured.

Pittsburgh, Pa., February 2.—An express train on the Baltimore & Ohio Railroad jumped the track at Woodell this morning, and crashed into a freight train standing on the siding. The engineer and fireman escaped with slight bruises.

Kent, O., February 5.—An Erie engineer was struck by a switch engine in the yards here this morning and his body horribly mutilated. He died instantly.

Roanoke, Va., February 6.—The boiler of a freight locomotive exploded here this evening. The fireman, Dean Henry, was instantly killed, and the engineer so severely injured that he died later from the effects.

Toronto, Can., February 8.—A collision occurred at Agincourt on the Grand Trunk Railway to-day between an express train and a snow-plough that had been sent to relieve it. The engineer and fireman on the express train were both killed.

Toronto, Can., February 8.—A collision occurred between an express train and a local freight near here this evening. Engineer Manning, of the freight, was so badly injured that he died, and his fireman was also seriously injured.

Williamsport, Pa., February 8.—A double-headed train on the Philadelphia & Reading Railroad was wrecked at Allenwood this morning by running into a deep snowbank. Engineer Ehlich was badly scalded.

Arverne, N. Y., February 8.—An express train on the Long Island Railroad ran into a snowbank near here this evening. Engineer Patrick Mahoney and his fireman, David Lavelle, were buried under the engine and crushed to death.

Lindsay, Ont., February 9.—An express train from this point to Toronto ran into a snowbank this morning, and the engineer is missing.

Pittsburgh, Pa., February 9.—William Metzgar, a fireman on the shifter of the New York & Cleveland Gas Coal Company, was killed on the tracks this afternoon. He fell from the locomotive and the cars cut off both legs. He died shortly afterward from the effects of his injuries.

Cincinnati, O., February 9.—The feed pipe on the boiler of a locomotive froze here to-day, and the boiler exploded. Engineer Frank King and Fireman David Henry were instantly killed.

Dover, Del., February 10.—There was an accident on the Philadelphia, Wilmington & Baltimore Railroad at this point to-day, in which Engineer Benjamin Connor was severely burned about the knees.

Le Roy, N. Y., February 10.—While four Lehigh engines were ramming a snowbank near here to day in order to release a stalled passenger train, the head engine overturned and the engineer, Edward D. Duryea, was caught underneath and instantly killed.

Pittsburgh, Pa., February 10.—Thomas Collins, an engineer on the Baltimore & Ohio Railroad, while trying to get his engine clear of a snow-drift in the Allegheny Mountains to-day had his hands, ears and feet frozen.

Rochester, N. Y., February 11.—William C. Cook, an engineer on the New York Central & Hudson River Railroad, was killed here this morning by striking his head against the woodwork of the bridge over the canal.

Le Roy, N. Y., February 13.—William Benedict, an engineer on the Buffalo, Rochester & Pittsburgh Railroad, fell from his engine here to-day and received such severe cuts about the head that he was rendered unconscious.

Pittsburgh, Pa., February 13.—Two engines on the Castle Shannon Railroad collided near the Monongahela incline this evening. Both engineers and one of the firemen were seriously but not fatally injured.

Rhinecliff, N. Y., February 15.—A freight train on the New York Central & Hudson River Railroad broke in two at this point this morning. When the two parts came together the engine was thrown from the track and into the river, taking the engineer and fireman with it. Engineer Donohue was so badly scalded and injured about the spine that he died from the effects of his injuries. Fireman Reed was also fatally injured.

Pittsburgh, Kan., February 16.—A passenger train on the Atchison, Topeka & Sante Fé Railroad was wrecked just outside of the city limits to-day by being backed into by a coal train. The engineer and fireman were slightly injured.

Guthrie, Ok., February 16.—A collision occurred on the Atchison, Topeka & Santa Fé Railroad between an express train and a stock train near here to-day. The fireman on the freight train had his leg crushed, and both the engineer and the fireman on the passenger train were killed.

Huntington, W. Va., February 18.—A passenger train on

the Norfolk & Western Railroad jumped the track west of here to-day. Engineer Jackson and Fireman Gaze were seriously hurt.

Phillipsburgh, N. J., February 18.—An express train on the Central Railroad of New Jersey ran into an open switch here to-night and was wrecked. The train dashed into a turntable siding on which there were four other engines and a caboose. W. E. Graveling, the fireman on the express, was pinned beneath his engine and badly injured, and two other firemen were badly bruised.

New Albany, Miss., February 19.—Engineer W. H. Milliner was shot and killed on his engine at this point to-day.

Troy, N. Y., February 20.—A collision occurred between an express and a freight train on the Fitchburg Railroad in the yard of this city to-day. The fireman of the express train was bruised.

New Orleans, La., February 20.—A passenger train on the Southern Pacific Railroad was wrecked by running into an open switch at Franklyn to-night. The engine turned over on its side and killed the fireman outright, while the engineer was fatally injured.

Danbury, Conn., February 21.—The boiler of an engine hauling a freight train on the New York & New England Railroad exploded here to-day. The fireman was thrown out of the cab and badly scalded. The engineer escaped unhurt.

Imlay City, Mich., February 22.—A tube in the boiler of a Chicago & Grand Trunk Railway engine collapsed here today. The engineer and fireman were slightly scalded.

Portsmouth, N. H., February 23.—A side-rod on an engine hauling a passenger train on the Boston & Maine Railroad broke a few miles from here this afternoon. The fireman, Frank Jones, was struck and seriously injured.

Webster, Mass., February 27.—There was a collision on the Norwich & Worcester Railroad near here this morning. Engineer Arthur Stoddard and Fireman Lewis Williams were slightly injured.

Our report for February, it will be seen, includes 31 accidents, in which 13 engineers and 8 firemen were killed, and 11 engineers and 16 firemen were injured. The causes of the accidents may be classified as follows:

Boiler explosions	3
Breaking in two	1
Broken side-rod	1
Collapsed tube	1
Collisions	7
Derailments	4
Falling from engine	2
Frozen by exposure	1
Misplaced switches	3
Run over	2
Shot	1
Snowbanks	3
Struck by obstruction	1
Unknown	1
Total	31

PERSONALS.

Mr. David Clark, after forty years' service with the Lehigh Valley Railroad Company, has resigned his position and retired from active duties.

Mr. Philip Wallis has been appointed Master Mechanic on the Lehigh Valley Railroad, in the place of Mr. David Clark resigned, and will have charge of the shops at Hazleton and Delano, and the foundry at Weatherby.

Mr. George S. Morison, Civil Engineer, has removed his Chicago office from 184 La Salle Street to Room 1742, Monadnock Block, corner of Jackson and Dearborn streets. His New York office remains at 35 Wall Street, as heretofore.

Mr. F. W. Chaffee has been appointed Master Car-Builder of West Albany Car Shops, of the New York Central & Hudson River Railroad, with headquarters at West Albany, *vice* Mr. L. Packard, deceased.

Mr. F. W. Mahl has been appointed Mechanical Engineer of the Southern Pacific Company, with headquarters at Sacramento, Cal. In addition to such duties as may be assigned to him by the Superintendent of Motive Power and Machinery at Sacramento, he is especially charged with the details appertaining to the establishment and maintenance of common standards for the motive power and rolling stock of the leased, proprietary, and affiliated lines of this Company.

PROCEEDINGS OF SOCIETIES.

The Forthcoming Railway Congress.—The Prince of Wales is stated to have consented to open the International Railway Congress at the Imperial Institute in the first week in July. The British Government has given notice that the foreign delegates to the conference will be received on the part of Great Britain officially, probably at the Foreign Office. The United States has joined the congress, and will send several delegates. The German railways, however, hold aloof.

Civil Engineers' Society of St. Paul.—At the meeting of March 4 Mr. Truesdell read a paper, entitled The First Engineer. Hero, in his opinion, was the man to be honored with this title. Hero was the first to formulate and practically apply, 200 years B.C., the principles of geometry and mechanics. This pioneer instructor in practical science invented land surveying and levelling, and perfected innumerable engines of war and other constructions.

Engineers' Club of St. Louis.—At the meeting of February 20 Mr. J. H. Curtis delivered an address on A System of Water Purification, which he has developed with special reference to the removal of organic matter. He has been experimenting for over two years and has discovered that where sand filters were not submerged, but where the water was allowed to drip upon the sand bed, just as rain falls upon the earth, particles of air followed the drops of water through the sand, making the most complete aeration possible. The author's experiments, however, has only been conducted on a small scale, and he was unable to give any figures as to the actual amount of purification or capacity of filter beds based upon actual service.

The Institution of Junior Engineers.—At the February meeting Mr. A. H. N. Smith, of the Great Northern Railway, read a paper on Locomotive Repairing Work. The author first dealt seriatim with the principal causes rendering repairs to locomotives necessary, the unique character of such work, the various modes of dealing with the different kinds of repairs, and the difficulty of estimating their cost. After a short description of the two classes of locomotive which could best be taken for illustrative purposes—namely, a fast passenger and a heavy suburban engine—it was stated that, excluding accidents, each engine would have run an average of about 75,000 and 55,000 miles respectively before being sent into the shops for repair.

The subject of repairs could well be considered under four divisions, (1) boiler, (2) frames, wheels, etc., (3) motion, (4) general work. The work usually required on the boiler consisted of patching of fire-box in various ways, putting in new tube-plates, tubes, and stays, and repairing of damage caused in the smoke-box chiefly by heated ashes. The life of a boiler (which depended very much on the nature of the material used in its construction and on the quality of the water with which it was fed) might be taken as 15 years if of steel, and 20 years if of iron. The proper adjustment of the lifts in the various clack-boxes was insisted on, such having an important effect upon the steaming of the boiler.

Repairs to cylinders were next considered, including patching of cracks. The use of asbestos for making joints was deprecated, as that material was found to corrode the cast iron; the mode of repairing such damage by brass patching was described. The facing up of the ports was then illustrated.

The manner of testing the frames for squareness, of repairing fractured horn-blocks, of fitting axle-boxes and marking them off for boring out received attention. The wearing of tires was then investigated, and interesting methods of discovering flaws in axles were enumerated. The letting together of brass motion bushes, the fitting and lapping of quadrant dies and links, the renewal of motion-pins, repairing of reversing-gear, the wear of piston cotters and eccentric liners were each fully treated upon, and the paper concluded with a description of the two processes of setting slide-valves—by the lead and travel—and practical observations on the fitting of regulator valves, the even distribution of the engine's weight on the springs, and repairs to the automatic brake-gear.

Engineers' Club of Philadelphia.—At the meeting of March 2 Mr. C. H. Ott described an ingenious solution of a problem in hydrostatics that had been brought to his attention at the town of Anniston, in Alabama. A well 80 ft. deep had been used as the source of water supply for the

town, but as the town grew this supply became inadequate, and a new well was started about 40 ft. east of the old one. A shaft was driven to a depth of 120 ft., where a flow of water was obtained. In order to provide storage for water, and to connect the new shaft with the old pumping-well, a timbered drift was run directly beneath and about 40 ft. below it. The water supply not yet being deemed sufficient, an 8-in. well, cased with pipe, was bored in the new shaft to a depth of 230 ft. below the pump-house floor, and a great flow of water was struck. The drill, in passing through the disintegrated limestone, bored a much larger hole than 8 in. in diameter, so that large quantities of water passed up outside of the casing. When the depth of 230 ft. was reached, the latter quantity was so great that the water-level in the new shaft could not be lowered and maintained with the apparatus at hand to more than about 20 ft. below the pump-house floor. An 8-in. hole was then drilled from the bottom of the pumping-well to the drift below. It was still found impossible with all of the pumps and jet apparatus available to lower the water-level in the pumping-well to more than about 25 ft. below the pump-house floor, thus furnishing an ample water supply.

Some months after these arrangements had been finished a failure occurred in the pump-cylinder under 50 ft. of water, and with no apparatus available to lower the water in the well sufficiently to make the necessary repairs. After several expedients had been tried, the following contrivance was devised :

A balloon-shaped bag in dimensions about 3 ft. in diameter and 6 ft. long was made of six plies of bed-ticking, roughly quilted into squares. The bag was soaked in linseed-oil and a quantity of rye flour inserted and well shaken around. An inch pipe terminating in a sleeve was inserted in the mouth of the bag, which was then securely wired around the pipe. Sewn to the bottom of the bag was a stout ring, and to this was wired a half pig of iron by a ring bolt inserted into its end. The bag was then wrapped tightly with twine into a cylindrical shape, and was lowered into the drill-hole in the pumping-well by means of sections of pipe until the weight struck bottom ; by estimation one half of the bag entering the drift below, the remainder being in the drill-hole. The inch pipe was then attached to the service main, through a stop-cock and a pressure-gauge attached thereto, and the bag was slowly distended until a pressure of 50 lbs. per square inch was reached and maintained. The upper part of the bag swelled out and accommodated itself to the irregularities of the drill-hole, the lower part of the bag swelled out into a bulb shape, the whole resembling an inverted champagne bottle cork. The drainage pump and steam jet were then set to work and speedily emptied the pumping-well, the bag being held in shape during the lowering of the water by an interior water pressure of about 10 lbs. per square inch in excess of the exterior water pressure. The repairs to the pump having been readily made, the water was exhausted from the bag and the apparatus withdrawn.

NAVAL AND MARINE NOTES.

Washington Coal.—It is reported that recent tests of Washington coal go to show that there is an unlimited source of good steam coal in the Puget Sound country.

Device for Stopping Shot Holes.—A device for stopping up shot holes in war vessels, invented by a marine engineer named Douglas, and accepted by the British Government, has been tested by the United States cruiser *Chicago*. It resembles a parachute with a rubber cover supported by steel ribs. It is pushed through the hole made by the shot, when it expands and clings close to the outside of the vessel, preventing an inrush of water.

The Blake Pump has been adopted by the Newport News Ship Building and Dry Dock Company for the United States gunboats Nos. 7, 8 and 9, the contract having been awarded to the George F. Blake Manufacturing Company, 95–97 Liberty Street, New York. The contract includes Blake's special design of vertical duplex boiler feed pumps, fire pumps, and bilge pumps, also an outfit of pumps for the distillers and evaporators.

Additions to the Navy.—Three new vessels will shortly be placed in commission—the armored cruiser *Maine;* the double-turret monitor *Amphitrite*, now ready for service at Norfolk ; and the third, the cruiser *Boston*, which has been lying idle at the Mare Island Navy Yard for months waiting a complement of men. Following close upon these ships will be the battle-ships *Indiana* and *Massachusetts*, and the monitor *Terror* at New York. The latter will be ready for service in April, and the battle-ships in the early summer.

Carrying Capacity of a Torpedo.—An experiment was recently made at Willett's Point to test the ability of the Sims-Edison torpedo to bear the weight of a man. A chair was lashed to the top, and the man stationed thereon took a ride at the rate of about 18 miles an hour, having the torpedo under perfect control at all times, the electric current being supplied from the shore.

The "Northland."—This vessel, which is an exact duplicate of the *Northwest*, was launched from the yards of the Globe Iron Works, at Cleveland, early in January. The two boats are the only ones on the great lakes ever built exclusively for the passenger trade. The electric plant includes a powerful electric search-light of 100,000 candle-power. She will carry 442 cabin and 211 steerage passengers, and a crew of 150 men. The *Northland* will run with her sister ship, the *Northwest*, between Buffalo, Cleveland, Mackinaw and Duluth. She cost about $750,000.

Test of an 18-in. Carnegie Armor Plate.—A nickel steel Harveyized armor plate was tested at Indian Head on March 11. Two shots were from a distance of 290 ft. from the plate. The first was a Carpenter projectile with a powder charge of 295 lbs. This penetrated about 4 in. and was broken to pieces, but did not crack the plate. A second projectile of the same kind was then fired with a charge of 395 lbs. of powder. It struck the plate about 2 ft. to the right of the first one, and penetrated 7 in., its base being again broken to pieces. A long, vertical crack was made, extending from the top to the bottom of the plate, but, unlike former tests, there was no longitudinal crack. The test was considered very satisfactory.

The British Admiralty and Dynamite Guns.—The New York *Sun* is authority for the statement that "a special committee has been sitting at the Admiralty, on and off, for months past, considering the question of pneumatic guns. Reports were received a few weeks ago from the United States which appear to have suddenly overcome the conservative reluctance to this new-fangled American thing, and orders have been issued for carrying out a series of experiments in Milford Haven. Absolute secrecy is observed on the subject at the Admiralty. Rumor has it that a gun has been brought from America for trial, and that a certain syndicate stands to win an enormous stake in the event of its proving successful. But another and equally credible report says that a pneumatic gun of British invention has been made at the Government torpedo works at Woolwich, where every foreman and mechanic is sworn to secrecy."

Telephoning to and from a Light-ship.—Professor Lucien J. Blake, of the Chair of Physics and Electrical Engineering at Kansas State University, at Lawrence, has recently been experimenting at Sandy Hook, with a view of establishing communication by wire between the land and a light-ship anchored several miles out in the ocean. The difficulty is that the ship riding at anchor is continually changing its position, and breaks any wire or cable that is fastened to it. Professor Blake conceived the idea—and has carried it out successfully in practice—of attaching to the anchor another chain leading toward the shore for a sufficient distance, so that neither the end of chain nor the water will be disturbed by the tossing of the ship, and there make his connection with the shore cable. This system was completed recently, and the first telephone message that ever passed between a ship anchored out at sea and the land was transmitted from Scotland Light-ship to Sandy Hook.

Dry-Dock at Port Royal.—This dock, which is nearly completed, is the largest in the country, and is capable of accommodating the great battle-ships now building. No other dock is large enough to hold them. Its length is 627 ft., with a maximum breadth of 76 ft. and minimum breadth of 44 ft., and is the first of the three large docks now building to be finished. The dock building at New York is practically of the same dimensions as that at Port Royal. A third dock, which is to be the greatest in the country, is now rapidly progressing toward completion at Puget Sound, and, when finished, will be the finest in the world. This dock is intended to be used in docking the battle-ships and large cruisers stationed on the Pacific Coast, where there are no facilities now adequate for the purpose.

Land has been purchased at Algiers, opposite New Orleans, for the site of a fourth great dock, and an appropriation of $250,000 has been asked by the Secretary of the Navy to begin the work, which will cost $1,250,000 when completed.

These docks will be ample, it is believed, to meet all requirements of the naval service for many years. The completion of the dock at New York will give that yard two first-class docks. There are now two at Norfolk, and the new ones at Port Royal and Algiers will make four in the South. The dock at Puget Sound and the two docks at Mare Island will be sufficient, it is said, for the Pacific station.—*New York Sun.*

Largest Tow Barge in the World.—Eastern capitalists, it is said, are to build at Chicago the largest tow barge in the world, the measurements of which will be: Keel, 352 ft. and 365 ft. over all; beam, 44 ft.; and depth of hold, 26 ft. On the present draft of 14½ ft. of water in the locks at Sault Ste. Marie the new boat will carry 4,500 tons. On the 18 ft. of water, when the 20-ft. channel between the great lakes shall have been completed, it will carry easily 6,000 tons. The vessel will have no spars at all for use of canvas, and will be towed exclusively. It will be of the best steel construction throughout. Ship-building in all branches promises to have an unprecedented boom at Chicago this spring. Contracts for two steamers nearly 400 ft. in length, and for two steel schooners with keels of more than 300 ft., have recently been made, and the capacity of boats under construction on the Calumet at the present time is about 24,000 tons. "The remarkable increase in the size of lake vessels this winter has been viewed," says a local paper, "with undisguised alarm by the owners of boats which have formerly done the bulk of lake carrying. They have viewed with considerable misgivings the coming of steamers and schooners which could take on board 6,000 tons in a single cargo with no corresponding increase in cost of operation. On what the outcome of this struggle between the old and new will be no two marine men can agree. It is evident, however, from the contracts which one ship-building company has taken, and the work of the other ship-yards around the lakes, that the coming lake carriers will be of the 6,000-ton class, and the owners of boats built before the 20-ft. channel became a part of the policy of the general government must adjust their interests to meet the competition of the larger craft."

Test of 15-in. Armor Plate.—A test of thick Harveyized armor took place at the Bethlehem Iron Company's proving ground recently, in the presence of Captain Sampson and the Armor Board. The plate was curved, 15 in. thick, 15 ft. 9.5 in. long, and 6 ft. 9.5 in. wide. It weighed 29 tons, and was held up to a backing of 36 in. of oak, by twenty-two 3.2-in. bolts. It represented the group composed of the 13-in. gun turrets of the *Indiana* and *Massachusetts*, composed of 24 plates, weighing in the aggregate 716 tons, the largest group of armor tested under the contract.

As the plate, which was comparatively narrow, was to be tested with the 10-in. gun, some anxiety had been expressed as to its liability to crack across, a method of failure which seems to be peculiar to thick and narrow Harveyized plates. This fear proved groundless.

The first impact was delivered upon the middle line, 18 in. to the left of the normal point, about the centre of the plate, with a velocity of 1,539 foot-seconds, the charge being 167 lbs. of brown powder. The 500-lb. shell penetrated about 5 in., its head welding fast and the remainder breaking up, the largest fragment, weighing about 50 lbs., rebounding 40 ft.

No cracks whatever appeared, nor were any of several chill cracks in the surface extended or deepened. The flaking was slight and the bolts and backing intact. The second shot, also a 500-pdr., struck the middle line of the plate, 36 in. to the right of the first, the velocity being 1,940 foot-seconds and the charge 241 lbs. It penetrated about 7 in., the head welding and the body and base breaking up. There was a trifle more flaking, but plate, bolts, and backing were, in all respects, sound and intact.

The New Torpedo-boats.—Proposals were opened at the Navy Department on February 19 for the construction, exclusive of armament and torpedoes, of three metallic twin-screw sea-going torpedo-boats of about 138 tons displacement with a speed of 24½ knots, maintained for at least two consecutive hours.

Proposals of two classes were permitted, one adhering strictly to the plans and specifications prepared by the Navy, and the other upon designs of the bidders fulfilling the conditions of speed and economy prescribed by the Department. The proposals will all be referred to a Board of Bureau Officers, including Chief Constructor Hichborn, Engineer-in-Chief Melville, and Judge Advocate-General Lemly, who will report to Secretary Herbert on the plans; and it is not expected that the contracts will be awarded for at least a month. The bids for the new torpedo-boats were:

Bath Iron Works, Bath, Me.—Department plan, all three boats, $142,000 each. Total, $426,000.

John H. Dialogue & Son, Camden, N. J.—Department plan: One boat, $136,000; two boats, $137,000 each; three boats, $135,000. Total, $408,000.

Columbian Iron Works, Baltimore.—Modified plan: One boat, $107,000; two boats, $103,000 each; three boats, $97,500 each. Total, $292,500.

Hugh Ramsay, Perth Amboy, N. J.—Five proposals. Modified plan, all three, $438,000. Another modified plan, all three, $378,000. Department plan, all three, $378,000. Department plan, all three, $347,700. Modified plan, all three, $347,000.

Union Iron Works, San Francisco—Department plan: One boat, $135,000; two boats, $129,000 each; three boats, $120,000 each. Total, $360,000. Modified plan: One boat, $125,000; two boats, $120,000 each; three boats, $116,000 each. Total, $348,000. Modified plan—Larger boat, 240 tons displacement and 28 knots speed, one boat, $243,000.

Fulton Engineering and Ship-building Works, San Francisco—Department plan: One boat, $148,000; two boats, $145,000 each.

Iowa Iron Works, Dubuque, Ia.—Department plan, all three, $137,000 each. Total, $411,000.

Herreshoff Manufacturing Company, Bristol, R. I.—Modified plan, three steel of 138 tons, for $113,350 each. Total, $341,550. Modified plan, three bronze hull, aluminum top, boats, for $138,000 each. Total, $414,000. Modified plan: One steel boat, $113,815; two composite boats, $138,000 each. Total all three, $389,815. Modified plan, one composite boat, $138,000; two steel boats, $113,850. Total, $365,700.

COMPULSORY ARBITRATION.

A BILL has been passed by the House of Representatives at Washington, "to establish a system of arbitration between carriers employed in inter-State commerce and their employés."

It provides that when a dispute occurs between "carriers" and their employés, that the Chairman of the Inter-State Commerce Commission and the Commissioner of Labor "shall, upon the request of either party to the controversy, with all practicable expedition put themselves in communication with the parties to such controversy, and shall use their best efforts, by mediation and conciliation, to amicably settle the same." If such efforts are unsuccessful, the bill provides for the appointment of arbitrators and the submission of the questions in dispute and the decision of the same. The bill provides further:

"That the respective parties to the award will each faithfully execute the same, and that the same may be specifically enforced in equity so far as the powers of a court of equity permit; except *that no employee shall be punished for his failure to comply with the award as for contempt of court.**

"That employés dissatisfied with the award shall not, by reason of such dissatisfaction, quit the service of the employers before the expiration of three months from and after the making of such award, nor without giving 30 days' notice in writing of their intention so to quit. Nor shall the employer dissatisfied with such award dismiss any employé or employés, on account of such dissatisfaction, before the expiration of three months from and after the making of such award, nor without giving 30 days' notice in writing of his intention so to discharge."

During the pendency of arbitration employers are prohibited "from discharging the employés, parties thereto, except for inefficiency, violation of law, or neglect of duty, nor for the organization representing such employés to order, nor the employés to unite in, aid, or abet strikes or boycotts against such employer. . . . Any violation of this section shall subject the offending party to liability for damages, which may be recovered in an action upon the case brought by any person, persons, or corporation who shall have received or incurred any loss or damage by reason of such unlawful act."

It is provided further, "that in the articles of incorporation and in the constitution, rules, and by-laws that a member shall cease to be such by participating in, or by instigating, force, or violence against persons or property during strikes, lock-outs, or boycotts, or by seeking to prevent others from working through violence, threats, or intimidation."

Section 6 provides that any violation thereof "shall subject the offending party to liability for damages." It is not made plain, though, how such damages could be collected from a labor union if it had no property, or from its members if they

* The italics are ours.—EDITOR.

had none. Members under this act cannot be punished for contempt of court, and the only penalty which apparently can be enforced, is that if he is guilty of instigating force or violence against persons or property during strikes, etc., or shall prevent others from working through violence, threats, or intimidation, "he shall cease to be a member" of his incorporated union. This is very mild punishment.

Another important provision is that incorporated unions "may appear by designated representatives before the board created by this act." The right of a union of appearing, or being represented by deputy, is one which has long been a subject of dispute between the employés and employers. It is a just claim, and is recognized in the act before us.

But what shall be said of a law which provides penalties which can be enforced against one party and not against the other? Before the unions should be authorized to appeal to such a board, they ought to give some adequate security to fulfil the provisions of the act, or pay the penalties imposed.

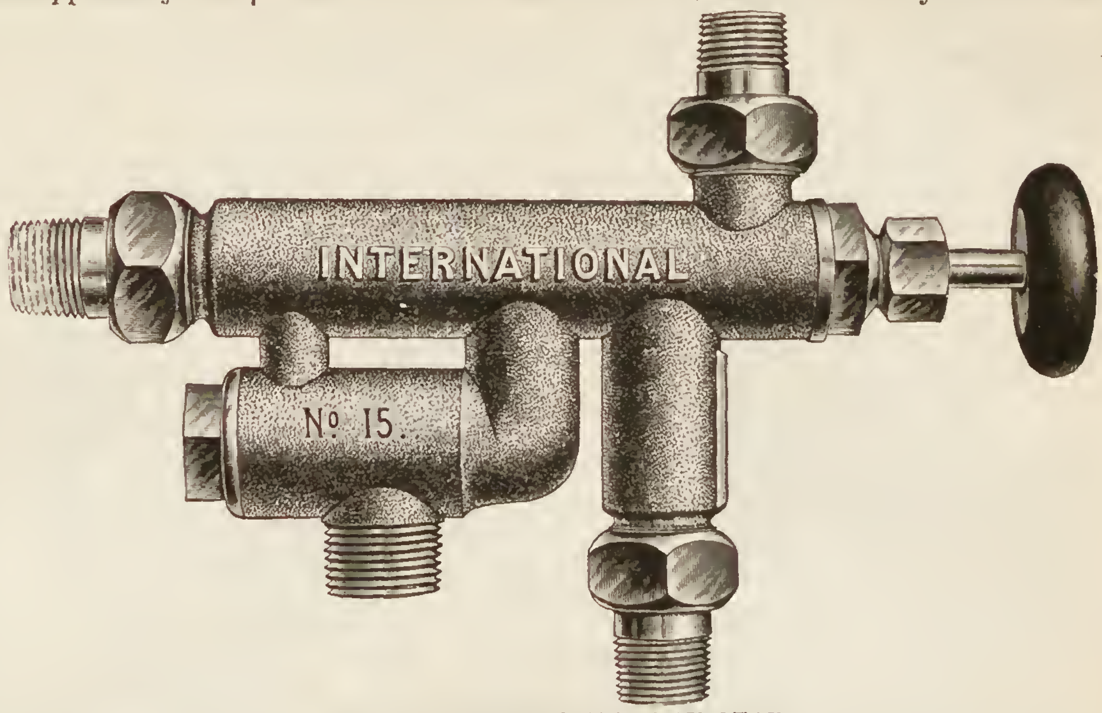
Compulsory arbitration would be tyranny, and would be sure to arouse a storm of indignation if it were enforced.

Manufactures.

THE "INTERNATIONAL" INJECTOR.

We illustrate herewith a new injector for which the makers claim remarkable and wonderful results. During the past few years a great number of automatic injectors have been put on the market, but in the main features and methods of operation they have in great measure copied one another, and none of them have been able to produce better results than others which have gone before. Up to the present time automatic injectors have been limited in their range, as it has always been found impossible to retain the automatic qualities and at the same time handle a hot water supply, or give the injector a greater range than 120 to 130 lbs. between highest and lowest steam pressures. The positive injector reached its limit 15 years ago; and while it has secured better results on hot water than the automatic injectors, yet a first-class positive injector is high priced, and requires considerable attention from the operator.

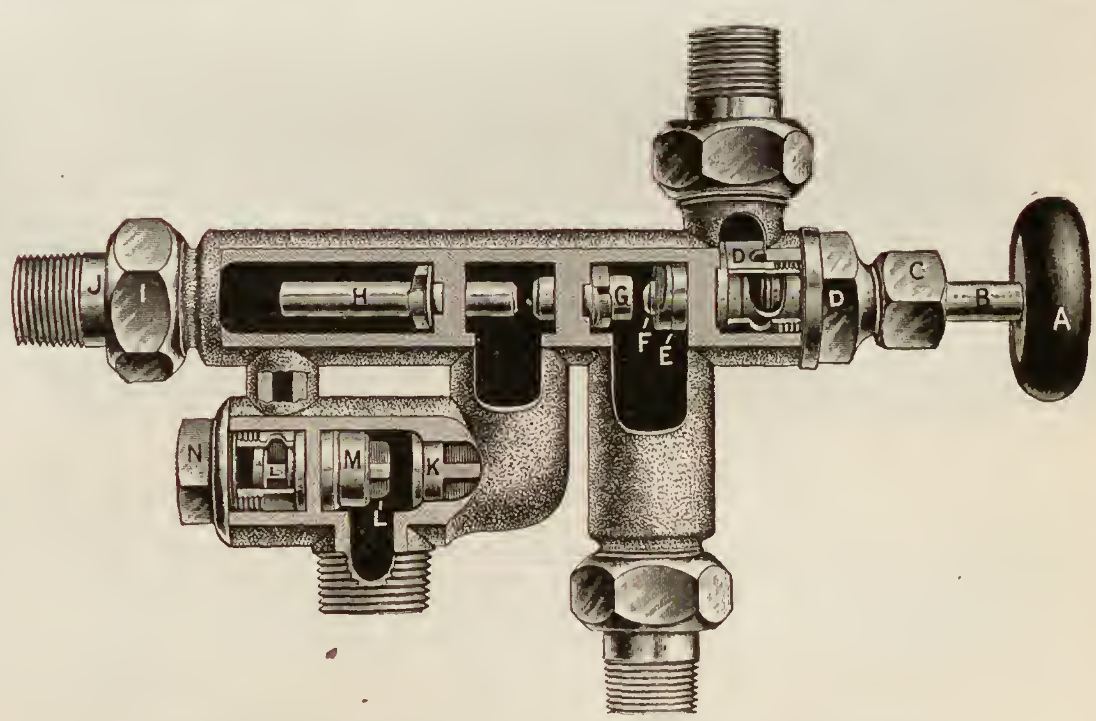
The "International" injector is a new departure, being based on new principles, by virtue of which it combines all the good features of both automatic and positive injectors of the past, and surpasses both in working qualities. The principal new feature in the "International" is the fact that the current of water to the boiler is established against atmospheric pressure instead of against direct boiler pressure, as heretofore. This is accomplished by the combination of an overflow valve, *K* (fig. 2), and pressure valve, *L*. When the injector starts, the steam passing through the steam jet *F* and suction jet *G* passes down through the overflow chamber, forcing valves *K* and *L* away from their seats, and opening the passageway through the overflow for the escape of steam, which by its pressure against the valve *H* holds both valves away from their seats. A vacuum being created between the jets *F* and *G*, the water is lifted, and passing through the suction jet *G* and combining and delivery jet *H* on its way to the boiler, passes down through the secondary overflow and out through the passageways between pressure valve *L* and pressure valve collar *M*. As the pressure increases in the delivery chamber around the delivery jet *H*, valve *L* is gradually forced to its seat against the collar *M*, but does not finally close until the current to the boiler is firmly established.



THE "INTERNATIONAL" INJECTOR.

The valve *K*, in the mean time, is closed by the vacuum in the overflow chamber. By a new construction of the parts in the steam chamber, the same valve handle *A* opens the valve admitting steam to the injector, and at the same time regulates the amount of water supply; therefore no valve is required in the suction pipe, nor is one necessary in the steam pipe except as a convenience should it be desired to remove the injector at any time while carrying steam on the boiler.

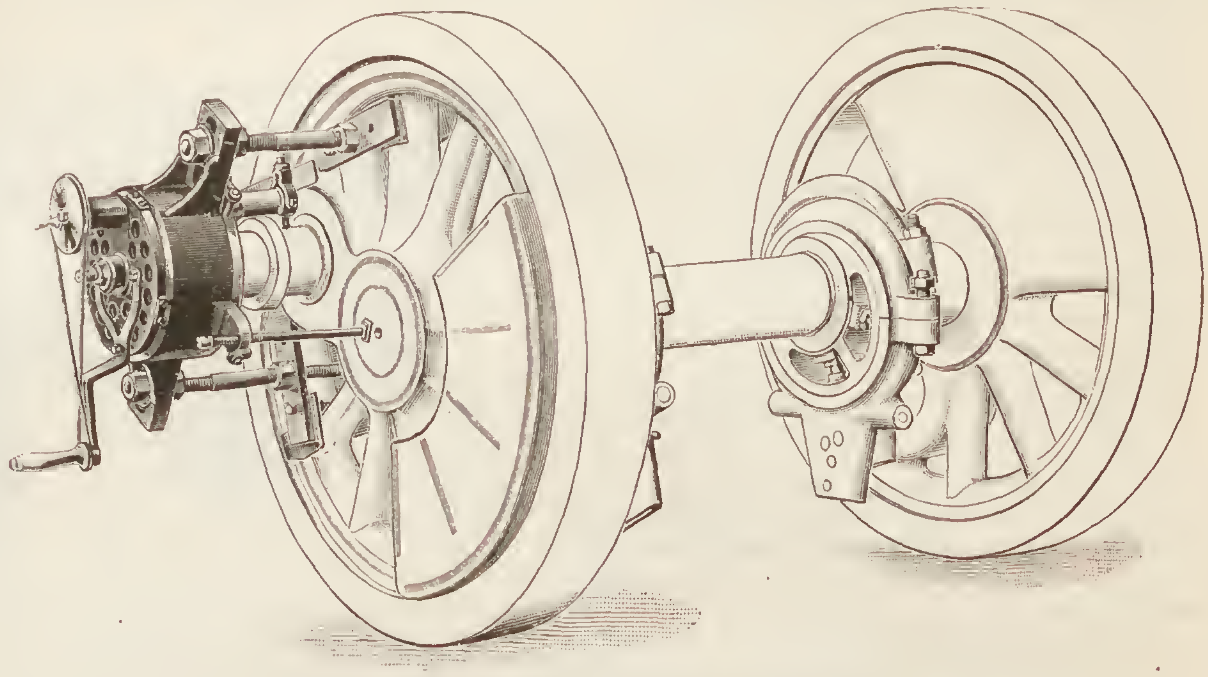
Another new feature is the fact that the combination and delivery jet *H* has no spill holes, and will therefore outwear three of any other make. The makers claim for this injector that it will start at 13 to 15 lbs. steam pressure and work from that point up to 250 lbs. steam pressure, giving it a range of 235 lbs., which is 100 lbs. greater than any other automatic injector. It is automatic and restarting at any and all pressures. It lifts the water vertically 20 to 22 ft., and handles a hot-water supply of 135° at 65 to 80 lbs. of steam, 125° at 125 lbs. of steam. By delivering the minimum capacity it will put water into the boiler at 200° at 80 lbs. of steam, and at 260° at 150 to 200 lbs. of steam, the water being taken from a 4-ft. lift at 74°. One of the most remarkable features about this injector is its grading capacity. The best injectors heretofore manufactured have a grading capacity of only about 40 to 50 per cent., while the minimum capacity of the "International" is $66\frac{2}{3}$ per cent. less than the maximum capacity of the same size. The parts are made interchangeable, and are all easily accessible for cleaning, and the injector is fully guaranteed. It is manufactured by the World Specialty Company, of Detroit, Mich., who will send descriptive circulars and price-list to any one inquiring for the same.



LONGITUDINAL SECTION OF "INTERNATIONAL" INJECTOR.

PORTABLE CRANK-PIN TURNING MACHINE.

This machine is of a very simple design, and works most effectively. It is so constructed that it will turn either long or short pins that are collarless or have a collar, and that, too, without the use of any offset tools. In order that the work may be perfectly true, the machine may be lined either with the face of the hub or with the bore of the wheel, and it will therefore run true with the original pin. For turning the outer end of pins the tool is held close to the main body of the machine, but for pins with two bearings an extension bar is used for reaching the inner one. A large shell is used to hold the working portions of the tool, and is clamped solidly to the wheel by the two large lugs shown in the engraving. There are also two smaller lugs that carry set screws which act as feet for it to stand upon and serve to true it into accurate alignment. At the centre of the shell there is a large set screw that enters the drilled centre of the pin and serves to secure the central adjustment.

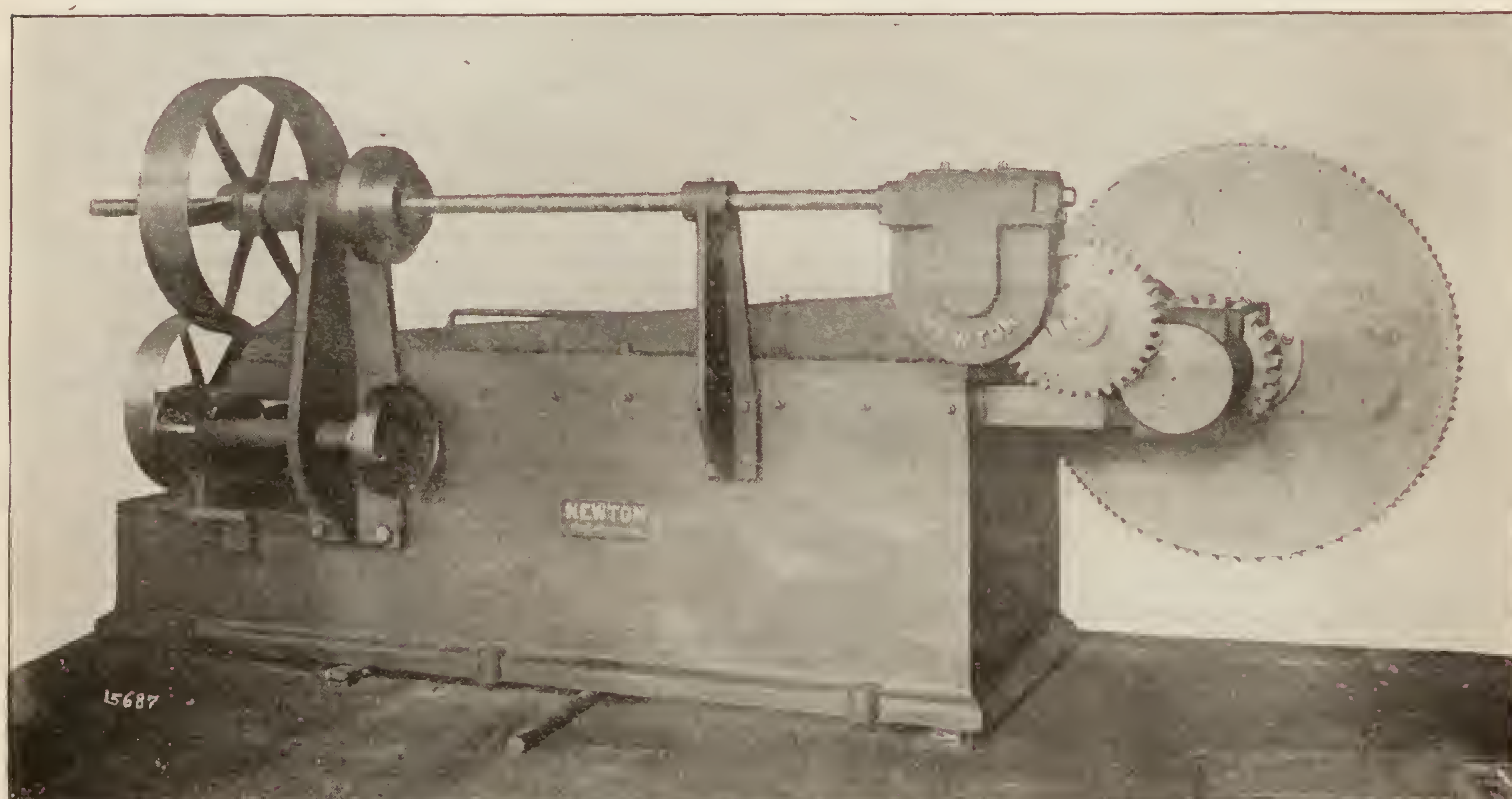


PORTABLE CRANK-PIN TURNING MACHINE.

Inside the shell there is a second shell that revolves, carrying a tool-post with it, this tool-post being fed out and in by a screw operated either by hand or the small belt shown. With this device, not only the bearing, but the faces of the collars, can be trued up. When it is desired to turn the inside bearing of a main pin, an extension to the tool-post is screwed into place, as shown in the engraving. The machine will true up all pins from 4 to 7¾ in. in diameter. The machine is built by Henry C. Ayer, of Philadelphia, Pa.

A LARGE CUTTING-OFF SAW.

The Midvale Steel Works, at Nicetown, have recently completed the construction of a large and finely appointed machine shop, to be used in connection with the heavy gun and other work that they are doing for the Government and the builders of large vessels. The new shop is equipped with electric travelling cranes of the Shaw design that span the whole floor, and are available for placing work in any of the tools. These tools consist of heavy gun lathes and planers, and among others the heavy cold saw made by the Newton Machine Works of Philadelphia, an engraving of which is given herewith. This machine is one of the largest cold sawing machines that has been built, and is intended for cutting off the ends of steel ingots that are to be used in the construction of heavy ordnance. The saw that is shown in place is 6 ft. in diameter, and is driven by the system of gearing that is brought out quite clearly in the engraving. Power is transmitted to the main pulley shown at the left, which is keyed to a sleeve through which the shaft carrying the worm gear runs, and is revolved by a feather in the sleeve. The work is blocked solidly, and the saw fed through it by a feed screw that is not seen in the engraving. As the head travels out it carries the worm with it, and the whole is supported by the ample bearing surfaces provided by the tail of the carriage. The rate of feed can be varied according to the size

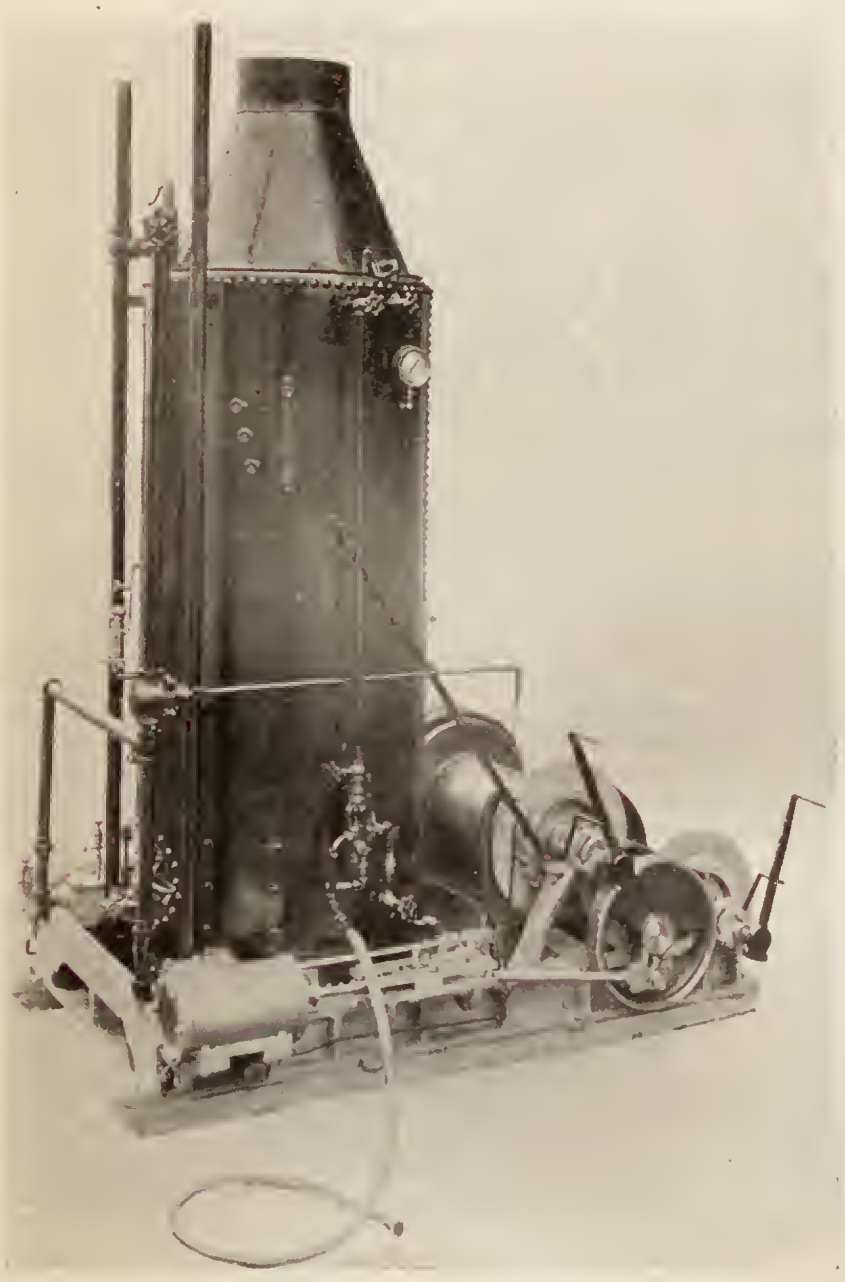


SAW FOR CUTTING OFF STEEL INGOTS AT THE MIDVALE STEEL WORKS.

of the piece to be severed, and the power of the machine is such that it will cut through an ingot measuring 20 in. × 20 in. in two hours.

MUNDY'S HOISTING ENGINE.

The hoisting engine and boiler, of which we give an illustration, is one that is made by Mr. J. S. Mundy, of Newark, N. J. While the whole machine is very compact and easily moved, the designer has apparently found that he had ample space within which to work, and has succeeded in so working out his details that all of the parts are readily accessible. The great difficulty that is experienced with many engines of this class is that the designer has utterly lost sight of the fact that machinery will not run forever without repairs, and the result is that no provision is made for rendering them easy. Everything about the engine itself is as easily inspected as though it was alone in the centre of a 10-acre lot. The steam chest, which is almost necessarily between the cylinder and the boiler, and which is usually crowded so close to the latter



MUNDY'S HOISTING ENGINE FOR RAILROAD WORK.

that the setting of the valve must be done with the aid of some wild guessing, is in this case flat, with the cover on top, and has the valve riding on a horizontal seat. The inspection and repairing is therefore easily and quickly done, without involving any contortions on the part of the repairer. The piston is packed by rings sprung into grooves in a solid head, and is turned a trifle larger than the bore of the cylinder. It is also thinner on the side where the split is made than on the opposite, the claim being that, in this way the outward pressure of the spring is made more even. Cast iron is used both for the cross-head and guides, and gives most excellent results The guides are of the four-bar locomotive type. Great care has also been taken in the counterbalancing of the cranks to produce even running. The hoisting drum is driven by a friction clutch composed of a cast-iron female and wooden male parts, bevelled to an angle of about 45°. The wood wears on the end of the grain and is very long lived.

The arrangement of the operating handles is clearly shown in the engraving, the whole being bunched together so as to be within easy reach of the driver. On one end of one of the spool-shafts, not shown in our engraving, it is customary to put a winch spool, for hauling in on any line that may be desired. Great care has been taken in the designing of the outlines of these spools, so that the ropes will deliver freely. Repeated trials at last evolved a form of spool that will do it, and this form is invariably used. Great care is taken in the workmanship and fitting, so that the inevitable day of repairing shall be postponed as long as possible.

Recent Patents.

WATER-TUBE BOILER.

Mr. John Vanes, of Brazil, Ind., has patented the water-tube boiler shown by fig. 1. It consists, as will be seen, of inner and outer cylindrical shells, *A* and *F*, with an internal fire-box, *G'*. Over this fire-box is a water and steam chamber, *J'*, and at the opposite end another water chamber, *J''*, is formed by the inner and outer shells and the tube-sheet *E*. As will be seen, both the tube-sheets *E* and *D* and the tubes *J* are inclined. There is a smoke and combustion chamber above

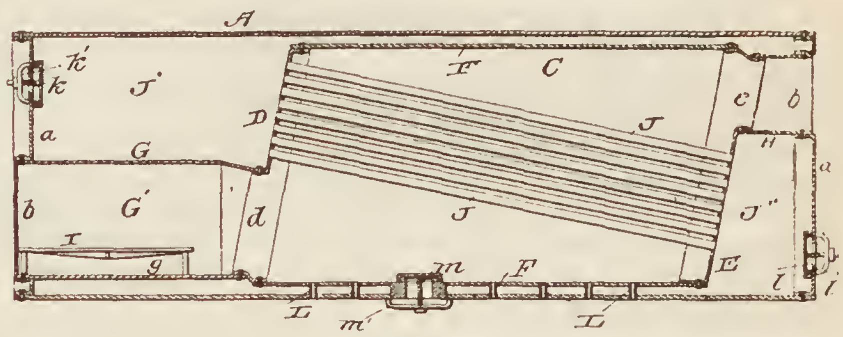


Fig. 1.

VANE'S WATER-TUBE BOILER.

and below the tubes, the passage *b'* leading to the chimney. Manholes *k* and *l* give access to the chambers *J'* and *J''*, from which the tubes may be cleaned or caulked or removed. The patent is dated October 16, 1894, and is numbered 527,631.

STEAM SEPARATOR.

No. 531,638, January 1, 1895. This invention is illustrated by fig. 2, which represents a section of the apparatus. Steam is admitted to it by the passage *b*. It then strikes the inclined plates *e e* and is deflected downward through the narrow passages *l l* around the pipe *g* into the chamber *k*. It then rises through the pipe *g* and passes through the passage *c* to its destination. It is claimed that the effect of the downward current is to deposit the watery particles contained in the steam in the chamber *k*, from which the water which is collected therein can be drained by a discharge pipe, *m*. John McCaffrey, of Pittsburgh, Pa., is the patentee.

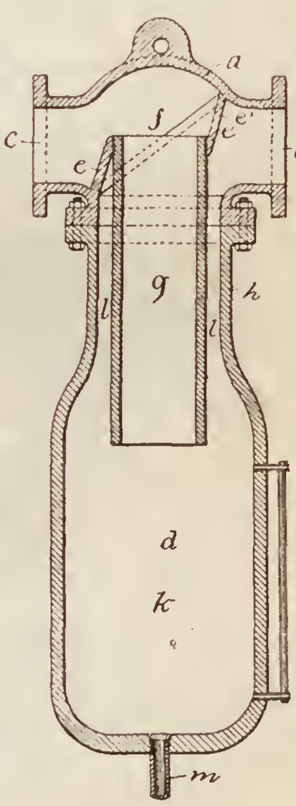


Fig. 2.

McCAFFREY'S STEAM SEPARATOR.

CYLINDER FOR ENGINES, MOTORS OR COMPRESSORS.

No. 533,240, January 29, 1895. Fig. 3 shows the form and arrangement of cylinder which Mr. Conrad Sonderman, of Landsberg, Germany, has patented. He describes his invention as follows:

"*A* represents the main shell or casing, the central portion of which is accurately bored and forms the low-pressure cylinder. In each end of the shell or casing *A* is placed one of the end sections *B C*, each of which is provided with a central bored chamber forming one of the high-pressure cylinders. I prefer to form the end sections *B* and *C* as shown with air spaces *H* between their inner and outer walls, the said air spaces acting to prevent to a certain extent the loss of heat from the high-pressure cylinders by radiation.

The end sections *B C* extend within the main shell or casing *A* to the bored portion which forms the low-pressure cylinder, and said end sections are secured to the main shell by bolts or screws or in any other desired manner.

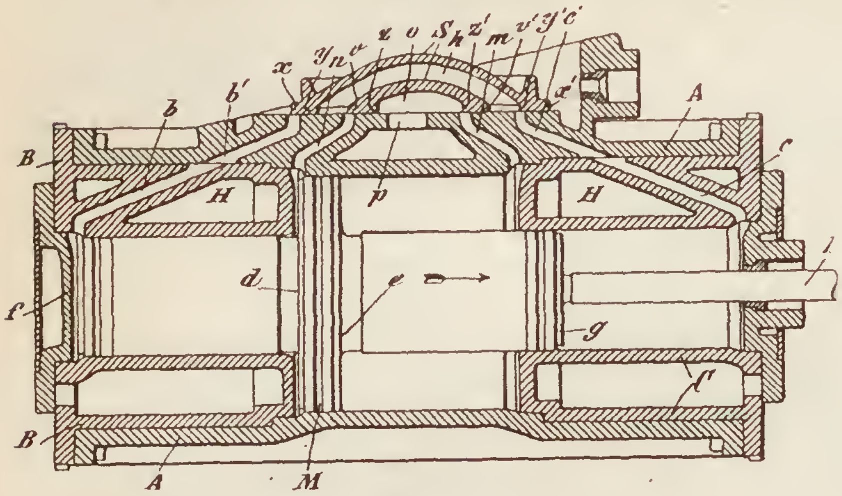
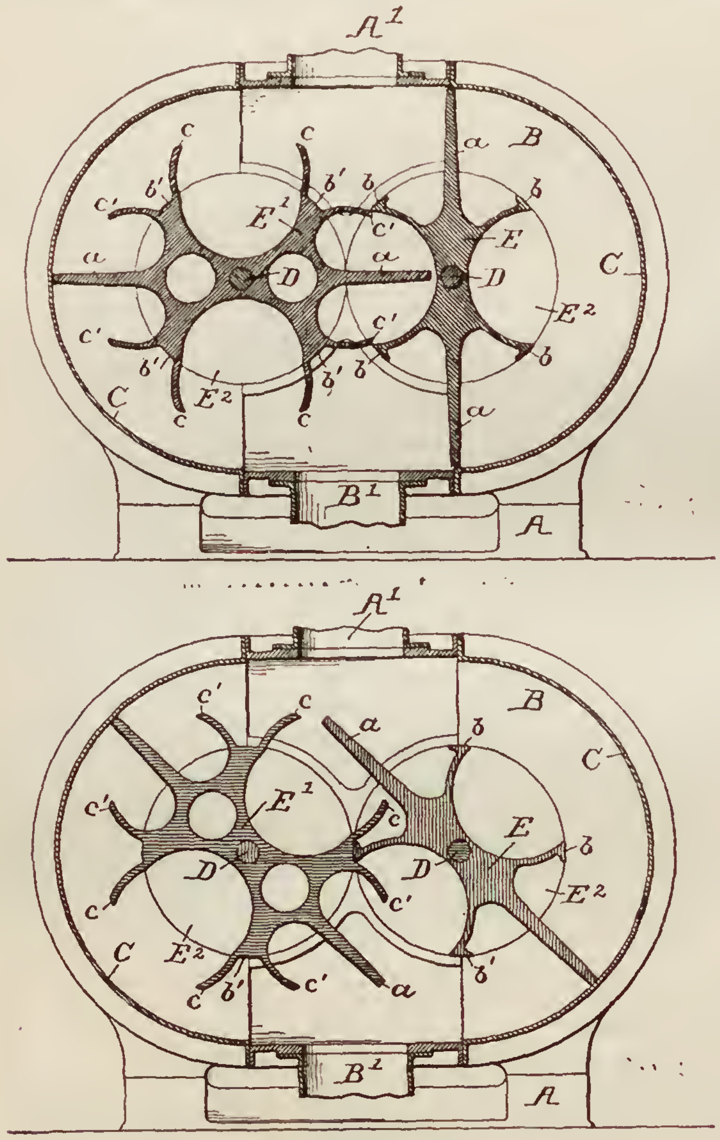


Fig. 3.

SONDERMAN'S COMPOUND ENGINE CYLINDER.

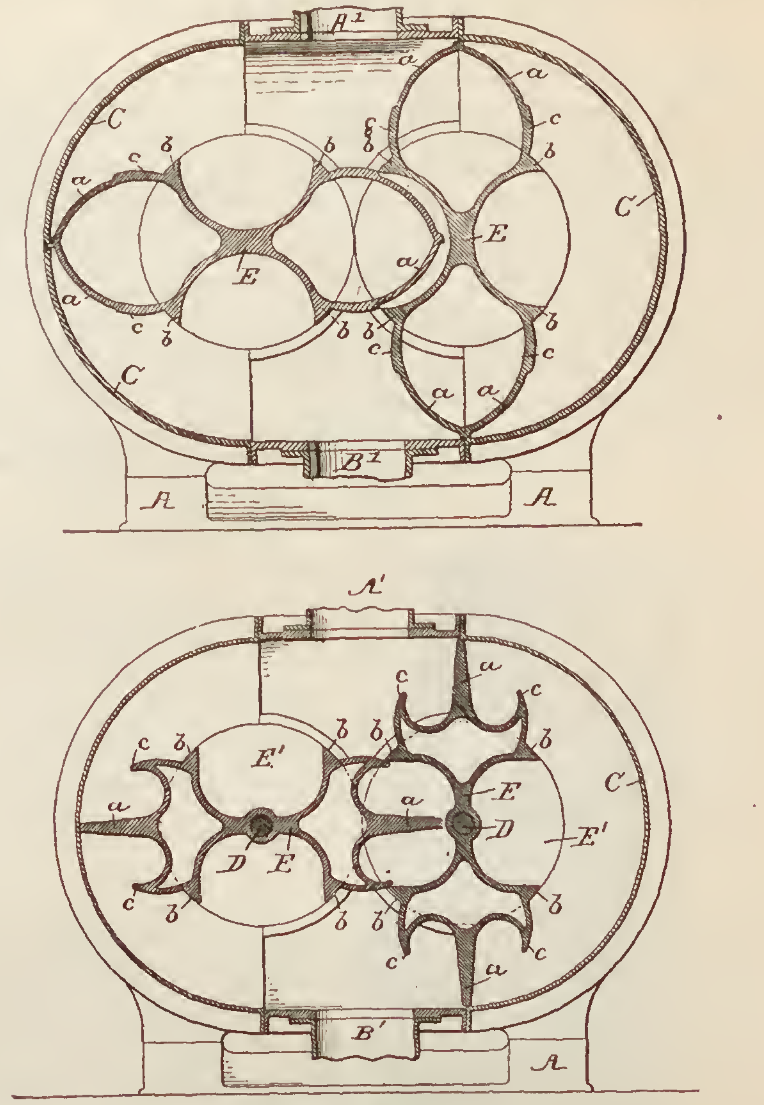
"The piston has a central portion, *M*, working in the low-pressure cylinder and end portions working in the two high-pressure cylinders. The two end sections *B C* are provided with suitable ports corresponding with ports *b' c'* with which the main shell *A* is provided. The slide valve *S* is of the Hicks type, and provides for the passage of the exhaust steam from the high-pressure cylinders to the low-pressure cylinder, the final exhaust taking place from the low-pressure cylinder through exhaust port *p*. By making the cylinder in this way it can be conveniently constructed and its several chambers may be accurately bored.



Figs. 4 and 5.

GREEN'S ROTARY BLOWERS.

"The cycle of movements in the working engine is as follows: In the position shown by the drawing the piston has completed its return stroke, and is now required to move in the direction indicated by the arrow. By the linear motion of the slide *S* the edge *x* opens the port *b b'* to live steam, and at the same time the edge *y'* opens the port *c c'* and allows the exhaust steam from the front high-pressure part of the cylinder to pass the edge *v* and through the ports *c c' h n* to the surface *d* of the piston in the low-pressure part of the cylinder. By the combined forces of the steam the piston and piston-rod *k* are moved forward, the live steam acting on the surface *f*



Figs. 6 and 7.

GREEN'S ROTARY BLOWERS.

and the low-pressure steam upon the surface *d*. At the same time the edge *z'* of the slide valve opens the port *m* to allow the final exhaust to leave the low-pressure part of the cylinder. In doing so it passes under the shell *o* of the valve and escapes through the outlet *p*. The exhaust from the front high-pressure part is prevented from passing from the passages

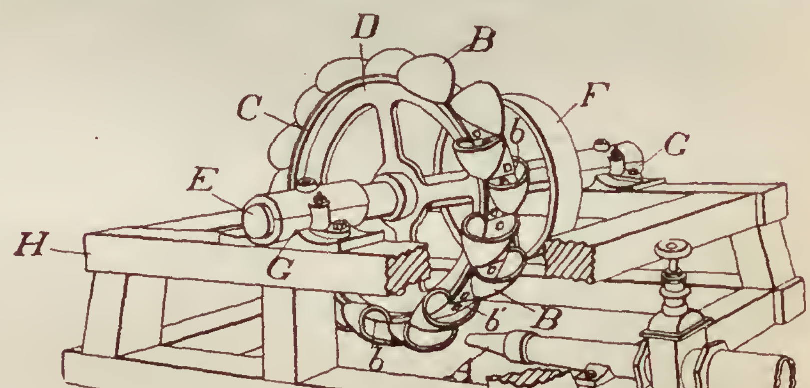


Fig. 8.

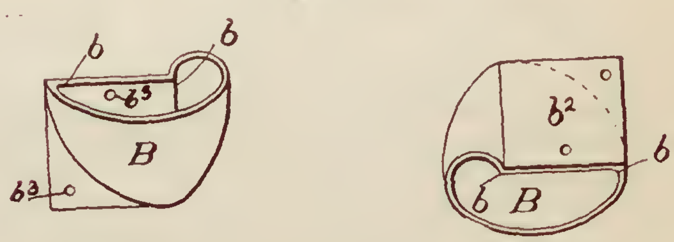


Fig. 9. Fig. 10.

TUTHILL'S ROTARY HYDRAULIC MOTOR.

c c' to the passage *m* by the edge *v'* of the slide valve. When the piston has completed its stroke the slide valve has advanced and opened the ports *c c'* by the edge *x'*, having passed the port *c'* so that the live steam may pass in, and the passage *m* is opened between the edges *y* and *v'* to exhaust the steam

from the back high-pressure part, while the edge z permits the escape of the exhaust steam from the low-pressure part through the passages n and m. This construction of cylinder may be adapted with advantage to locomotives and traction engines.

"With gas and petroleum motors the low-pressure part is used as a pump and the two high-pressure parts to develop the power, the spaces H in the shells of the high-pressure parts B and C being connected with a water supply for cooling purposes. If it be desired to use the construction in an air or gas compressor, the air or gas is drawn in through the passage p and brought alternately through the front and back high-pressure ports."

ROTARY BLOWERS.

Nos. 533,291, 533,292 and 533,293, January 29, 1895. In these patents Mr. Thomas W. Green, of Philadelphia, has described some very ingenious forms of rotary blowers, the construction of which will be sufficiently apparent from the engravings (figs. 4, 5, 6 and 7) without other description. The improvement consists in the form and construction of the "revolvers," which engage with each other in pairs.

ROTARY HYDRAULIC MOTOR.

No. 534,772, February 26, 1895. Of this invention the patentee, Mr. Stephen J. Tuthill, of Ashland, Ore., says:

"Its object is the thorough transfer of working force from a jet of water moving with high velocity to a water-wheel of this description through the agency of buckets of original design.

"It consists particularly in the individual shape of the buckets, which, each by its single flat side, is bolted upon the face of a wheel set vertically, in such manner as to be firm in place and to present to the jet a bucket mouth, the edges of which may be thinned and rounded, extending quite across and alternately over and below the opposite edges of the wheel face, thus preserving a wide opening through which the water, having given up its energy as the buckets leave it, may drop into the sluice beneath the motor. Such buckets are readily removed and replaced, and their size and that of the wheel and connections depends upon the pressure of fluid at hand."

Fig. 8 is a perspective view of the motor, and figs 9 and 10 separate views of one of the buckets. A is the nozzle terminating the service pipe by which the jet is directed upon the buckets B. The easy curving walls and bottoms of the buckets turn the stream gradually from its first course during such a period of its flow through them as will cause the resultant of the pressure due to the momentum of the water to be exerted in the central vertical plane of the wheel and face, in this way avoiding injurious lateral vibrations.

ROTARY WATER MOTOR.

No. 534,916, February 26, 1895. Columbus K. Rogers, Salem, Mass., inventor. Figs. 11 and 12 are respectively longitudinal and transverse sections of this motor, which consists of two pairs of motor wheels D and D' having curved blades d d' of the form shown. These wheels are mounted on shafts C and C', on which pinions F F' (shown by dotted circles in fig. 11) are secured. These pinions gear into a spur gear, G, attached to the motor shaft g, which is also provided with a fly-wheel, H, and band pulley h.

Above the wheel chamber B is located the pressure chamber E, which is separated from the wheel chamber by a partition, B^4, which is of the form of two arcs of a circle arranged side by side upon a common base, which shape causes the partition to closely conform to the shape of the motor wheels. The partition B^4 is provided with two series of ejector nipples that project downward at a tangent to the two wheels, the nipples of both series being inclined in the same direction so that the wheels will be rotated in the same direction. From the centre of the partition B^4 depends a division wall, B^3, that extends down to the motor shaft g and separates one motor wheel from the other and prevents any back pressure on the blades of the wheels, and also prevents any water ejected against one of the motor wheels striking the other. The chamber E is connected by means of a pipe, e, to any suitable source of water pressure.

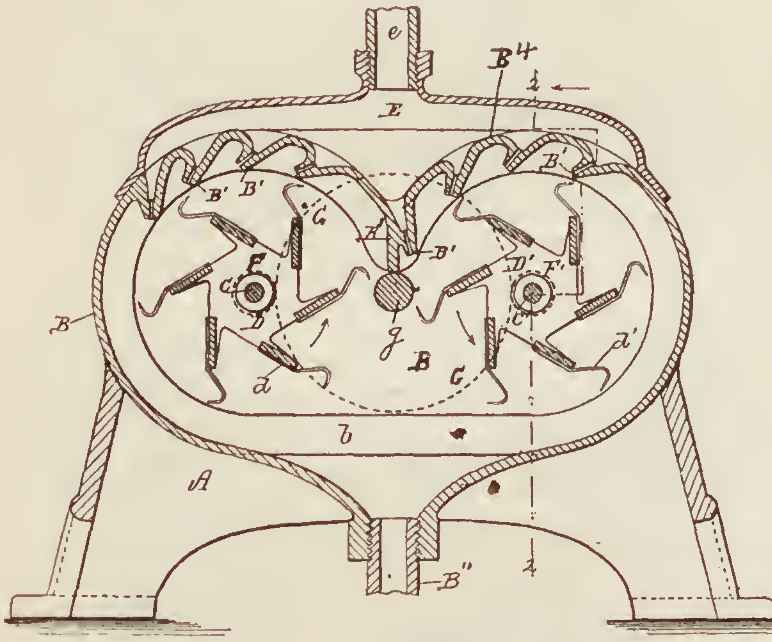


Fig. 11.

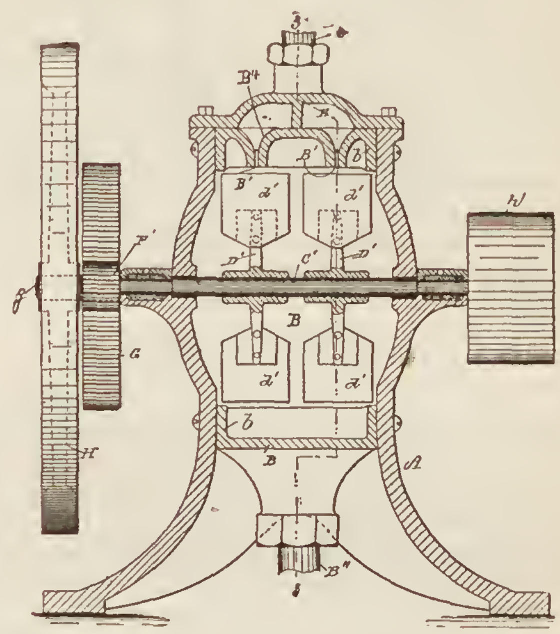


Fig. 12.

ROGERS' ROTARY WATER MOTOR.

The water from the pressure chamber E is forced through a series of ejectors B' B' against the fans or wings d d' of the wheels D D', thus causing the latter and their shafts to be set in a rotary motion.

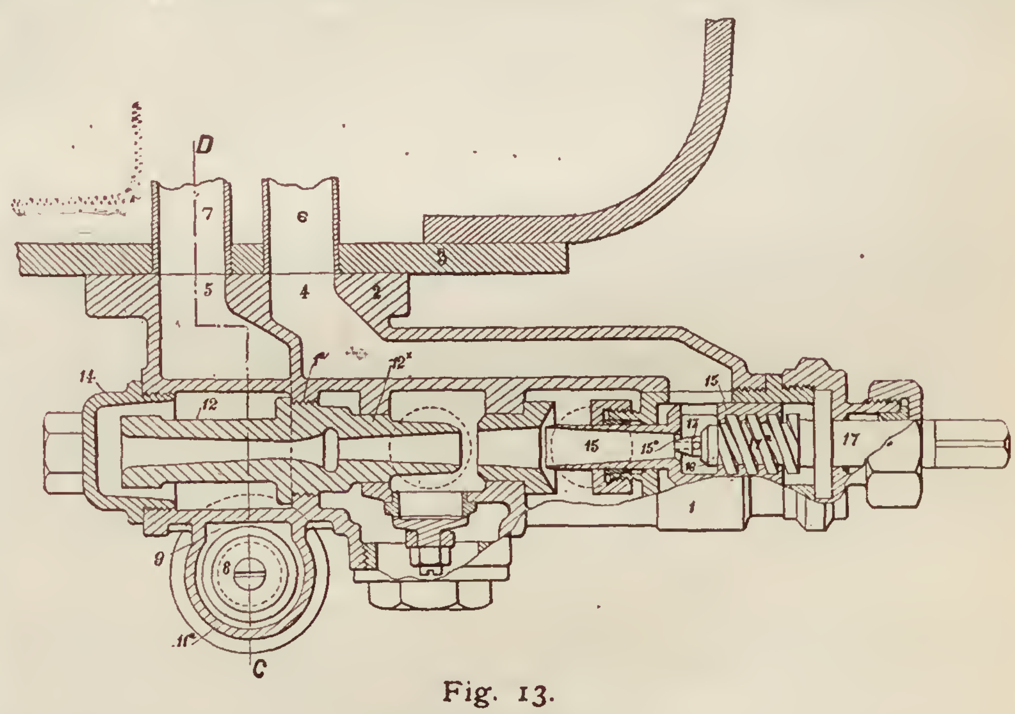


Fig. 13.

BROOKE'S INJECTOR.

INJECTOR.

No. 534,194, February 12, 1895. Robert Grundy Brooke, of Blackpool, England. This is an improvement in what are known as combination injectors, in which several boiler fittings, usually separate and distinct from the injector, are combined in the one apparatus. An object of this invention is to construct an injector of the type referred to in such a manner

that it can be conveniently fixed to any part of the boiler, and so that its various parts can be more conveniently taken apart than has hitherto been usual. For this purpose the injector is constructed with a self-contained non-return or check valve, having its case so formed and arranged in relation to a specially formed delivery passage that the seat of the said valve, as well as the valve itself, can be made removable without breaking any of the injector joints or connections; that the injector can be fixed with its body near to the boiler shell; and that the combining and delivery nozzles can, if desired, be readily withdrawn from the delivery end of the injector casing.

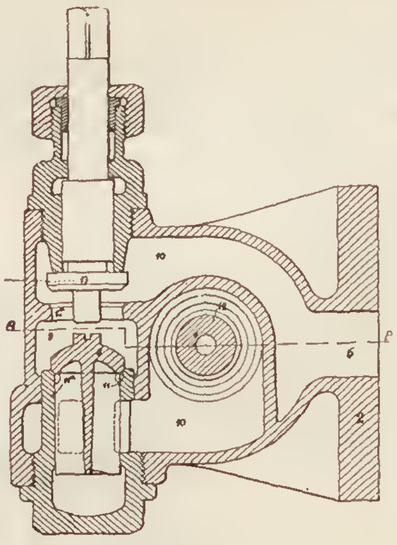


Fig. 14.
BROOKE'S INJECTOR.

Fig. 13 is a horizontal section on the line *A B* of fig. 14, and fig. 14 is a vertical cross-section on the line *D C* of fig. 13.

The inventor describes his invention as follows:

"1 is the injector casing formed with a flange, 2, by means of which it can be fixed to a boiler shell, 3, with its steam inlet 4 and delivery outlet 5 directly opposite steam and delivery pipes 6 and 7 respectively arranged within the boiler and so that the body of the injector can be close up to the boiler.

"8 is the self-contained non-return or check valve arranged within a case, 9, and serving to check the return flow of water through the specially constructed delivery passage 10. 11 is the valve seat.

"The valve case is arranged at the side of the injector casing away from the flange 2, and the delivery passage 10 is arranged transversely to the delivery nozzle 12, so that the water from the delivery nozzle will first pass outwardly and away from the final delivery outlet 5 until it passes through the valve case 9, whence it will pass back in a direction toward the final delivery outlet and thence into the boiler. By this construction it will be seen that the valve seat 11 for the non-return valve 8 can be formed on a tubular part, 11^a, adapted to be screwed into the bottom of the valve case, so that the valve seat and the non return valve can be readily removed for refacing or other purpose and then be replaced without breaking any of the injector joints or connections.

"The injector may, as shown, be provided with a stop valve, 13, adapted when moved on to its seat 13^a to close the delivery passage 10 at a point between the non-return valve 8 and the boiler, so that the said non-return valve, together with its seat, can then be removed while the boiler is under steam."

It would seem as though it would be a more compact arrangement and give greater security against accident if the check-valve 8 was placed between the injector and the boiler instead of outside of the former.

BOILER.

No. 534,673, February 26, 1895. William Schmidt, of Wilhelmshöhe, near Cassel, Germany.

In the American Engineer for February, on page 89, a description was given of Schmidt's boiler and of some remarkable results which were attained in tests made with it in Germany. Since then a patent in this country has been issued to Mr. Schmidt, which contains a fuller description than the one which was given in our February number of the construction and operation of his boiler. As many of our readers will doubtless be interested in knowing more about this boiler, which has produced such remarkable results, the engraving of the Schmidt patent is reproduced here and literal extracts from the specification are given. In describing his invention Mr. Schmidt says:

"The purposes of the improvement are, first, to control the degree of superheating by means of the regulator, as well as by means of a feed-water heater; second, to prevent the superheater from being exposed to the furnace gases before steam can flow through the same; and, third, to exhaust the furnace gases to the highest possible degree, as will all be more fully described hereinafter.

"In fig. 15 *a* designates the boiler proper, *b* the furnace, *c* the passage for the furnace gases, *d* a flue arranged centrally above passage *c*, and *e* a casing held by the boiler *a*.

"The superheater *f*, which consists of a column of flat, horizontal coils, is arranged within the annular space between the flue *d* and the casing *e*, and communicates with the boiler *a* by the bent pipe *f'*. The steam thus flows through the coils *f* in the same direction as in the furnace, so that the wet steam, on being acted on by the hottest gases of the furnace, is first dried, and is thereafter superheated. The superheated steam escapes at f^2.

"The feed-water heater *g* consists likewise of a column of flat, horizontal coils, and is arranged above the superheater within the annular space between tube *d* and casing *e*. The feed-water enters the coils *g* at the upper end g^2 of the latter, and flows to the boiler *a* through the connecting-pipe g^5. It will be seen that the feed-water, contrary to the steam, flows in a direction opposite to that of the furnace gases. The latter are thus acting first on that part of the feed-water which has already been heated, while the cold water is subjected to those gases which are nearly wholly exhausted.

A small space is left between the superheater and the feed-water heater, and at that place the tube *d* is provided with a number of apertures, *d'*. Said apertures may be closed by a circular slide, *h*, which is connected with a lever, *i*, by means of a rod, *k*. The latter has a collar, *k'*, by means of which may be raised the lid *l* that is closing the upper end of flue *d*. It will be seen that lid *l* can be raised only after the apertures *d'* have been freed from slide *h*. This arrangement now works as follows: Suppose that all parts be in the position shown in the drawings, and the boiler be fully at work, the steam flowing through the superheater will be dried and superheated by the furnace gases that pass through the annular space between flue *d* and casing *e*. The furnace gases are hindered from escaping through flue *d* directly to the chimney *m*, as a lid, *l*, as well as the apertures *d'* are closed. If now from any cause the superheating of the steam becomes too great, the slide *h* is raised by means of lever *i*, so that the apertures *d'* become free of said slide. The furnace gases, instead of passing through the space containing the superheater, will then pass through the lower half of flue *d*, and will flow from thence through the apertures *d'* to and through the space containing the feed-water heater, so that the heating of the feed-water is increased, the superheating of the steam however decreased. As a matter of course the superheater need not wholly be deprived of the action of the heat, but only as much as necessary to reduce the superheating to its normal degree. The slide *h* therefore is raised only as little as necessary to obtain that result. It will be seen that the action of the furnace gases upon the superheater and the feed-water heater may be regulated in any required degree by correspondingly adjusting the said slide *h*. If the furnace gases shall be hindered to act even on the feed-water, the lever *i* is raised still more, so that lid *l* is lifted by means of the collar *k'* or rod *k*. Nearly the whole amount of the furnace gases is passing then straightway through the central flue *d* and up into the chimney *m*, so that during that time there is practically neither a heating of the feed-water nor a superheating of the steam. It will be seen that also in this case the lid *l* may be raised but very little at first, so that part of the furnace gases is escaping directly into the chimney and part of the same on the by-way through the space containing the feed-water heater.

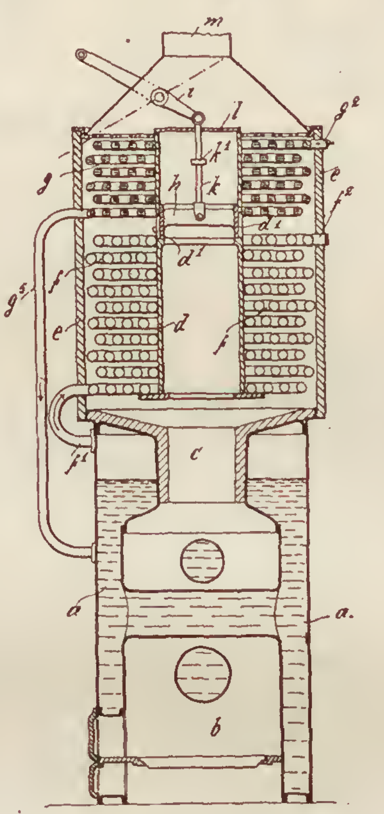


Fig. 15.
SCHMIDT'S SUPERHEATED STEAM BOILER.

"When the fuel in the furnace has been kindled anew the position of the lid is that last described—*i.e.*, the lid is fully raised so that the gases coming from the furnace *b* may freely escape into the chimney without being able to act on the two columns of the pipes *f* and *g*. This is of great importance in that as there is no steam yet within the superheater, the latter is prevented from being overheated. As soon, however, as the steam has reached the required tension for the respective engine, communication (which has been interrupted up to then) between the boiler proper and the superheater is established, so that the latter becomes filled with steam, and the lid *l* and slide *h* are lowered down to the position shown in the drawings, when the whole apparatus will commence to work as described."

AERONAUTICS.

UNDER this heading we shall hereafter publish all matter relating to the interesting subject of Aerial Navigation, a branch of engineering which is rapidly increasing in general interest. Mr. O. Chanute, C.E., of Chicago, has consented to act as Associate Editor for this department, and will be a frequent contributor to it.

Readers of this department are requested to send the names and addresses of persons interested in the subject of Aeronautics to the publisher of THE AMERICAN ENGINEER.

THE LILIENTHAL FLYING MACHINE.

HERR LILIENTHAL, of Berlin, has for many years past been working at the problem of flight, and as he now seems to be fairly successful, an account of his apparatus and the method of using it will perhaps be of general interest.

He has constructed two machines—one for soaring flight only, the other with a carbonic-acid motor for rowing flight. He kindly showed me both of them at his practice ground, near Berlin, with the method of using them, and allowed me to try the soaring machine myself.

Previous to constructing his machines, Herr Lilienthal tried a number of experiments to ascertain the pressure and line of action of the air on surfaces of different shapes. His experiments are fully described in his book, "Der Vogelflug als Grundlage der Fliegekunst," but the following are the principal results from them:

1. Soaring flight can be successfully accomplished without motive power, provided there is wind. The birds, when soaring, do not expend any power, all their movements being due to their own weight and the force of the wind.

2. Experiments with small rotating apparatus give far smaller wind pressures than experiments conducted in the open against the moving air.

3. With plane surfaces there is much less lifting power than with slightly curved surfaces.

4. The line of action of the resultant air pressure is not normal to the surface of a plane or to the chord of a curved surface, but varies greatly according to the angle of inclination of the surface. With curved surfaces, at small angles, it acts forward of the normal.

5. Repeated experiments show that the wind does not flow horizontally, but has a slight trend upward of about 3°. In warm weather this angle may be very much increased.

6. When the wind is blowing directly against the machine, the lifting power is largely increased.

7. When the wind is moving in the same direction as the machine, the latter must move faster than the wind, or it will be forced downward.

8. Although it is possible to proceed in any direction by soaring flight only, such a process will generally be very slow, and it is consequently desirable to have a motor powerful enough to drive a machine in a given direction without soaring.

9. A man is not powerful enough to work a wing-flapping machine under all circumstances.

10. Only the outer half of a wing should flap, the inner half being for sustaining and not for driving.

Herr Lilienthal has up to the present constructed two machines, and he is now constructing a third one of a slightly improved pattern. His first machine is for soaring only; it weighs 40 lbs., and he has succeeded in soaring flight very fairly well. His longest flight was about 400 yds., and he has been 200 ft. up in the air. His second machine is very similar to the first, but the outer halves of the wings feather, and it is fitted with a small carbonic-acid motor weighing 40 lbs., capable of working the machine for about one and one-half hours on a fair day. The machines are made of willow and canvas, the willow being bent into the necessary shapes to suit the curvature. The arching of the wings is one-eighteenth of the spread at the deepest part, running out to nothing at the wing tips. The outer halves of the wings move through an angle of about 30°; there is no hinge, only the spring of the wood.

Both machines are very neatly made, all the attachments being very carefully designed. Most of the guys underneath are of wire; those above and connecting the tail are of stout cord.

The new machine will be very like the second one, but the surface will be slightly larger, the machine itself rather lighter, and the wing tips will work on a hinge. The piston-rods will be attached to the wing levers directly, and not by chains and pulleys, as in the second machine.

Herr Lilienthal's practice ground is at Lichterfelde, about 7 miles from Berlin. The hill from which he takes a preliminary run is about 150 ft. high, with an average slope of $\frac{1}{2}$. Four yards around the top is a grassy slope; the remainder of the slope is covered with sand, in case of accidents. The first thing to be learnt is how to use the machine without a motor, and a good deal of practice is required to get off the ground and keep one's balance when in the air.

Starting.—Stand on the top of the hillock, facing the wind, and hold the machine so that the wings are about level. Then take a sharp run downward for about 4 or 5 yds., and you will feel yourself rise in the air and float gently down the slope, the inclination of which will depend on the force of the wind; the legs to be kept well to the front.

Moving to Right or Left.—Throw the weight of the body toward the direction it is intended to move.

Coming Down.—In coming down, when the feet are about 3 ft. from the ground, throw the legs and weight generally well back and tip the wings backward.

A good deal of practice is required to use the machine well. Herr Lilienthal is very expert at it; on a perfectly calm day he glided downward a distance of about 90 yds. As regards using the motor, this was tried for the first time on the day of my visit; only one or two flaps were given, as Herr Lilienthal is very rightly very cautious when trying anything new. The movement of the wing tips did not in any way disturb the equilibrium.

The following appear to be the principal points to be attended to when practising:

1. A beginner should commence on a day when there is very little wind. He should not start from any great height. I commenced by starting from a point about one-fourth of the way up the hillock, and gradually worked up to a point about 6 yds. from the top.

2. It is necessary to take a good sharp run.

3. The machine should fit the operator, just as a bicycle should have dimensions suited to the person using it. I found this particular machine rather awkward to hold, as the arm rests were too big for me.

4. It is not safe to practise in a breeze of more than about 22 miles per hour with such light machines. If the wind exceeds the above, greater weight should be taken up, in what proportion, however, has not yet been determined.

5. No difficult feats should be attempted at first. What is wanted is to learn the use of the machine, and get accustomed to being in the air.

6. Gusty weather is specially dangerous, as it makes keeping the equilibrium very difficult.

7. Until the operator is well accustomed to the use of his machine, he should not attempt turning round to move with the wind. When turning, wide sweeping circles should be used.

8. When landing, the weight should be well thrown back, the object being, of course, to stop the forward velocity.

9. The manœuvres performed by birds should be carefully studied.

The following works contain a good deal of information about Herr Lilienthal's work, and are well worth studying:

1. "Der Vogelflug als Grundlage der Fliegekunst." Von Otto Lilienthal, Berlin, 1889.

2. "Progress in Flying Machines." By O. Chanute, C.E., New York, THE AMERICAN ENGINEER AND RAILROAD JOURNAL.

3. "The Proceedings of the German Aeronautical Society." Berlin.

4 *Prometheus*, weekly Berlin scientific paper.

J. D. FULLERTON, *Major, R. E.*

CHATTENDEN, November 14, 1894.

—Royal Engineers' Journal.

HARGRAVE'S RECENT EXPERIMENTS.

MR. LAWRENCE HARGRAVE, of Stanwell Park, Clifton, New South Wales (after many preliminary experiments) has now been building and sailing models of flying machines since 1885. He first built 10 machines driven by india-rubber bands in tension, with which he obtained a maximum flight of 270 ft. He next built six machines driven by compressed air, the

best of which flew 312 ft. (No. 14), and is now in the Field Columbian Museum at Chicago. Then he constructed two model machines driven by steam (Nos. 17 and 18), and although no very long flights were obtained with them, he satisfied himself that sufficient power could be carried to insure flights of a mile or more by steam, could the equilibrium be insured for such considerable distances in the open air.

Mr. Hargrave accordingly next turned his attention to the question of automatic equilibrium under varying conditions of wind, and in 1893 he produced his "cellular kites," described and illustrated in a paper contributed to the Conference on Aerial Navigation at Chicago (August, 1893), which paper has been published in Aeronautics and in the proceedings of the conference.

It seemed clear to Mr. Hargrave that if he and his motor and propeller mounted on a cellular kite, or a gang of them, could be safely raised from the ground in a wind and steadily fly, restrained by the kite line, then, by exerting sufficient thrust through a propeller of some sort, to slacken the line, he would to all intents and purposes be flying at the velocity of the wind; so that if he then slipped his moorings he could probably fly to leeward at twice the velocity of the then prevailing wind.

During the last 18 months Mr. Hargrave has greatly simplified and improved these cellular kites, and they are no longer the crude affairs described in 1893. They are now provided with two central longitudinal spines or booms, one over the other, and these chords are trussed together, thus forming a stiff vertical frame to which the cells are attached. The latter are made to fold up like an umbrella, so that the kites can be furled into a space equal to their length multiplied by their depth. This is accomplished by providing diagonal struts inside the cells, with a hinge at one end and an angle-iron shoe at the other. These shoes slide along the top and bottom members of the longitudinal trussed frame, and either brace out the cells or, when slipped out, allow the outer corners to come inward and the kite to furl, as indicated by the figure *C* in the accompanying engraving.

When the kite is furled the central main frame is somewhat limber sidewise, but when the cells are strutted out they act as bracing cantilevers and the whole structure is rigid.

The frame is all made of American red wood and the cells are of inferior calico; the top and bottom are stretched transversely to the line of motion by curved ribs, so as to present a concavo convex surface to the air.

These cellular kites are said by Mr. Hargrave to be perfectly stable and certain in their action, and to need no careful adjustment. They are raised with common clothes lines —three-rope yarn manilla—which is not easy to handle when under strain.

Mr. Hargrave has provided himself with five of these kites. These are shown in the engraving, not as they are grouped in actual flight, but when brought together under a tree on a still day for purposes of photographing. Their weights and dimensions are given in detail in the table herewith:

SIZES AND WEIGHTS HARGRAVE CELLULAR KITES, 1894.

Kite.	Length of each cell.	Breadth of each cell.	Depth of each cell.	Distance between the cells.	Distance from the forward end of the forward cell to the point of attachment of the kite string.	Weight of the kite.	Lifting surface of the kite.
A.	1′ 11″	5′ 0″	1′ 10½″	2′ 1″	1′ 7″	5 lbs. 7oz.	38.5sq.ft
B.........	1′ 11″	5′ 0″	1′ 10½″	2′ 4″	1″ 7″	5 " 14 "	38.5 "
C...	2′ 3″	7′ 8⅛″	1′ 10¼″	4′ 5″	2′. 8″	9 " 8 "	69 "
D	2′ 6″	6′ 6″	2′ 3½″	3′ 6″	2′ 3″	9 " 0 "	65 "
E.........	2′ 6″	9′ 0″	2′ 6″	4′ 0″	2′ 10″	14 " 8 "	90 "

Now that the Australian summer has come, Mr. Hargrave has begun experimenting with these kites. He had an assistant, but says that under more favorable circumstances as to locality, and with a winch on the sling seat, he could readily dispense with aid.

On November 12, 1894, the outfit shown in the engraving was carried to the sea beach, and kites *A B* and *C* were raised. *C* proved to be weak at one corner, and the right-hand side of the forward section collapsed. This did not prevent it from still flying steadily, aided by *A* and *B*, but it was taken down, kite *D* substituted and kite *E* was added and raised.

Kites *A B D* and *E* were then flying in tandem on the same line, the distances apart being as follows: *A* to *B*, 52 ft.; *B* to *D*, 46 ft.; *D* to *E*, 46 ft.; while from *E* to the ground the distance was 6 ft., and it was secured by a gun tackle purchase to the spring balance and the two sacks of sand shown in the engraving. The group of kites was then pulling 180 lbs.

The sling seat was then toggled on, and Mr. Hargrave got aboard, with a hand anemometer to measure the speed of the wind and a clinometer to measure the angles of incidence. The assistant then slacked away the tackle line to the end. The apparatus was then 42 ft. to the leeward of the sand bags and veering with the wind round an arc of 40°. This was unexpected, as the wind was well to the eastward of south-southeast and the coast-line trends north-northeast and south-southwest. At this stage of the proceedings there were only a few pounds of the total weight unsupported by the kites, the feet of Mr. Hargrave being still on the ground. The velocity of the wind was 14.7 miles per hour, the pull on the spring balance was 120 lbs., and the slope of kite *E* with the horizon was 15°.

Thus matters continued for about a quarter of an hour, when the wind freshened and raised Mr. Hargrave from the ground. The velocity of the wind was then measured at 18.6 miles per hour, the spring balance reading 180 lbs.

Then the wind slacked off and lowered Mr. Hargrave back to earth. Several wind puffs next occurred, and ascents were made, but not of sufficient duration to read the anemometer, which is equipped with a two-minute sand-glass.

At length a long and strong wind gust arrived, and Mr. Hargrave went up like a shot. A careful reading of the anemometer showed the wind velocity to be 21 miles per hour, and the pull on the spring balance was 240 lbs.

The total weight raised and sustained aloft was then:

The four kites *A B D* and *E*	35 lbs.
The Toggles, lines, anemometer, sling seat...	7 "
Mr. Hargrave	166 "
Total............	208 "

which were supported by the 232 sq. ft. of lifting surface in the four kites, or at the rate of 0.90 lbs. per square foot; this being 41 per cent of the 2.2 lbs. of pressure to the square foot, corresponding to a wind of 21 miles per hour.

The angle of incidence of kite *E* was 15°, and that of *A B* and *D* was about the same; the angle measured from *E* to the kites above being nearly 60°, and the forward end of the cells being partly open to view. The angle of the tackle line may be said to have been 35° with the horizon.

The height of the sling seat above the ground was 16 ft., and on coming down Mr. Hargrave was enabled to haul himself and the kites to the moorings without leaving the seat. The line leading from this seat to the forward end of kite *E* is intended to allow the operator to cause the kite to tilt forward, thus advancing the position of the centre of gravity and diminishing the "lift" so as to come down gently. On this occasion this operation was unnecessary, as the wind slacked off during every ascent, and the operator always alighted very softly.

The altitudes attained were not great, but Mr. Hargrave says that the conditions would have been identical if the kites had been restrained by a mile of piano wire instead of the clothes line. He thinks that this experiment marks an epoch in his work, and that the entire steadiness of the apparatus in the wind establishes two facts:

1. That this extremely cheap, simple and compact apparatus can be made, carried about and flown by one man; and

2. That a safe means of either lifting up a flying machine from the ground, suspended to the kites, or of turning the latter into the flying machine itself, and, after adding a motor, making an ascent; of trying the apparatus without any risk of accident; and of coming down gently, is now at the service of any experimenter who wishes to use it, for Mr. Hargrave takes out no patents, and throws open his work to other aviators in order to expedite joint progress.

THE HIGHEST BALLOON ASCENSION.

In this journal for March, at page 145, Professor Berson, of Berlin, gives some facts regarding the highest point attained by Glaisher in his ascension of September 5, 1862, and also regarding his own high ascension in Berlin on December 4, 1894.

There has been so much misunderstanding in regard to Glaisher's memorable ascension that I am sure a careful study of the facts may well be published at this time. Glaisher himself laid claim to a height of 37,000 ft., but as he was unconscious at about 26,000 ft. we must accept this with great caution. The French have placed Glaisher's height at 29,000 ft., and now Professor Berson places it at 27,900 ft. I have made strenuous efforts to obtain, though without avail, the

weight of balloon and appurtenances with the passengers; also to obtain the lifting power of the gas, which was the last that comes off in the distillation from coal, but could hardly lift more than 45 lbs. to the 1,000 cub. ft. A careful study of the meagre facts which have been published has shown that the gas used could not possibly carry the balloon to any such height as claimed. Glaisher's claim rests upon a certain supposed rate of ascent when he became unconscious, and his rate of descent when he recovered consciousness. I have found, however, that a balloon never starts back at once, even though the valve has been pulled; and for this reason most of the time while Glaisher was unconscious was spent in going horizontally. This is borne out all the more by the fact that Coxwell, the aeronaut, was paralyzed in all muscles except his neck, and the slight opening, if any at all, caused by pulling the rope in his teeth would not release much gas. Here are the facts:

Glaisher's last reading before becoming partly unconscious gave 26,350 ft. as the height, and a temperature of about —4°. A previous reading at 23,380 ft. gave a temperature of 8°. This shows a fall of 3° per 1,000 ft. A very delicate minimum thermometer, which had been accurately tested, gave —12° at the highest point, and, adding the 2,667 ft. indicated by this to the previous reading, we have 29,017 ft. as the highest point attained. Allowing full effect to Glaisher's claims, I am sure that the evidence is conclusive that the height was between 29,000 ft. and 29,500 ft.

Professor Berson's last reading showed the barometer 9.12 in. and temperature —54°. If we consider that all the errors in the barometer and thermometer had been allowed for, and also that the temperature at the earth was 37° and air pressure 30.02 in., we have a height of about 28,750 ft. as the highest made in this voyage. This is without doubt the highest elevation at which accurate observations have been made, and was possible in this case only because of the supply of oxygen carried up.

There is a slight misprint in the account on page 146, where it is stated that the mercury in the barometer froze at —20°. Every one knows that mercury freezes at —40°. It seems strange that the balloon in this case was filled full of gas at starting, as this would necessitate taking up more than 1,000 lbs. of ballast, all of which would have to be emptied with some exertion. If the start had been made with a balloon one-third full, the same height could have been reached without exertion, and the aeronaut would have been in a condition to rise 3,000 ft. higher, as he himself suggests.

H. A. HAZEN.

March 9, 1895.

HARGRAVE'S RECENT EXPERIMENTS WITH KITES.

AERONAUTICAL NOTES.

Proposed Aerial Bicycles.—A German manufacturer has produced a bicycle driven by a gasoline engine, which is said to travel at the rate of 31 miles per hour. A French inventor has also completed a somewhat similar machine, and the French aviators are discussing the best way of availing of these motors in flying-machine experiments.

French Exposition of 1900.—A sub "committee on aerostation," under the presidency of Commandant Renard, is discussing plans for bringing about an international exhibition of aeronautical apparatus. It is proposed to include not only

balloons of all kinds, but also flying and soaring machines, and to open the competition to foreigners upon the same terms as to the French exhibitors.

This committee, however, in discussing its plans, has felt it its duty to call the attention of the governing authorities to the danger, as regards national defence, of allowing photographs to be taken of navigable balloons in the air, and to suggest that regulations shall be adopted "to prevent abuses in this respect."

This seems to indicate that Commandant Renard desires to exhibit the French military balloon under full headway, but is apprehensive that some of his secrets might be surprised.

The Last of the Antwerp Balloon.—We published in the American Engineer for October, 1894, the descriptions and illustrations of the proposed navigable balloon which was expected to form one of the attractions to the Antwerp Exhibition. This, it will be remembered, was to travel along a suspended cable, the driving screw taking its power from an electric trolley. Many unfortunate delays had occurred, but it was still hoped to get into operation before the close of the Exhibition.

These hopes proved futile. After spending six months and a good deal of money in the endeavor to get the enterprise in working order, the skin of the balloon was found to be so weak as to lead to continual rents and consequent escapes of gas. These were patched from time to time, and the balloon was filled about three quarters full and allowed to rise; but one end rose higher than the other, the balloon practically stood on its head, and the sun heating the contained gas at the stern, the balloon burst like a bomb. This is the end of the enterprise.

Steam Propulsion and Aerial Navigation Foretold by Roger Bacon in 1618.—A correspondent, M. de Fonvielle, calls the attention of the editor of *Nature* to one of Roger Bacon's essays, published in 1618, in which some of the possibilities of steam are vaguely foreshadowed, and aerial navigation is declared to be a thing of the future. The following quotation is from a translation which he furnished to that paper, and which reads like Mother Shipton's prophecies: "Instruments may be made for navigating without any men pulling the oars, with a single man governing, and going quicker than if they were full of pulling men. Wagons also can be made so that without any horse they should be moved with such a velocity that it is impossible to measure it. . . . It is possible also to devise instruments for flying, such that a man being in the centre if revolving something by which artificial wings are made to beat the air in the fashion of the birds. . . . It is also possible to devise instruments which will permit persons to walk on the bottom of the sea. . . . All these things have been done in old times and in our times, except the instrument for flying, which I have not seen, and I have not known any man who saw it done."

A New Dirigible Balloon.—The French newspaper *Patrie* of November 27, 1894, reports that experiments have just begun near Paris with a new dirigible balloon, the invention of Mr. H. Gadiffert.

It is stated to be of cigar shape and of 50,000 cub. ft. capacity, being somewhat similar to the Renard and Krebs military balloon *La France*, which, it will be recollected, was of 65,000 cub. ft. capacity. The mode of construction, however, is different, the net being replaced by a light cuirass of aluminum, to which are attached the various lines which suspend the car. The balloon is equipped with two propelling screws, one on each side, of novel design (which the inventor terms "accumulators"), being shaped much like an ordinary funnel for decanting liquids. These screws are driven by belts, leading to a winch in the car, and can be rotated in either direction, this being effected by handpower for the present.

Around the borders of the car a narrow aeroplane, which the inventor terms an "arrow," is attached. It can be detached or adjusted at various angles at will, and is expected to give the apparatus an upward or a downward direction under flight, in accordance with the angle of incidence presented.

During the first trial in November this aeroplane was not attached for prudential reasons, but the screws were relied upon both to propel and to change the direction of flight. The balloon was inflated with ordinary coal gas, and went up with three passengers. It rose quite rapidly some 2,600 ft., and then one of the screws was brought into action, whereupon the balloon turned around one and one half times upon a vertical axis, and took a position quartering with the wind, which position it maintained until ready to land. When both the screws were brought into action the apparatus attained an altitude of about 4,600 ft., without throwing out any ballast. Repeated trials having apparently indicated that the balloon readily responded to the action of this new form of screw, the aeronauts descended as night approached, and when near the ground brought the balloon head on to the wind by means of one of the screws, thus effecting a safe landing.

It is expected that further experiments will be made as the weather permits, probably next spring.

In the absence of precise data as to the relative speeds attained and the power applied, it is difficult to pass judgment upon the merits of this new proposal. The chances are that, like its many predecessors, it will prove inadequate to stemming brisk, ordinary winds; but it is possible that there may be some merit in the design of the screws, and that the aeroplane, when attached, shall give some control over the up or down direction, thus economizing ballast and gas, and prolonging the trips. It may safely be predicted, however, that whatever may be its merits for war purposes, this new dirigible balloon cannot attain commercial speeds, or carrying capacity, without resorting to enormous dimensions, even greater than those of transatlantic steamers.

Life-Saving Balloons.—Recently Professor Carl Meyers has completed at the balloon farm at Frankfort, N. Y., the first of a series of balloon outfits to be supplied to some 60 vessels belonging to New York parties for life-saving purposes in case of shipwreck. Each outfit consists of an automatic apparatus generating hydrogen gas under pressure, so controlled by a stop-cock that the closing of this immediately stops the generation or flow of gas and retains it still under pressure. This is used to rapidly inflate a balloon of sufficient size to carry a life line ashore from a wrecked vessel by means of which a heavier cable may be drawn for communication or passage of crew or goods as now practised by the governmental life-saving crews where stations exist for throwing a line by use of a mortar. The defects of the mortar system are that the stations are infrequent on the coast, the difficulty great in throwing a line against the wind at so small a mark as a ship, and the distance which frequently makes such efforts futile. The balloon system has the advantage of requiring no special apparatus on shore, while the balloon simply is drifted toward a line of coast by the same wind which blows the ship ashore, and drops its line when the shore is reached.—*Utica Observer.*

RECENT AERONAUTICAL PUBLICATIONS.

A New Flying Machine. H. S. Maxim. *Century Magazine*, January, 1895. An illustrated description of his machine by the inventor.

The Oakes Scheme. E. Oakes. *Danville* (Ill.) *Daily News*, November 10, 1894. An essay on the flying machine, proposing a combination of a balloon with aeroplanes.

Flying Apparatus. Otto Lilienthal. *Zeitschrift für Luftschiffahrt und Physic der Atmosphere*, June, 1894. A general discussion of the designing and experimenting of soaring devices.

Experiments in Aeronautics. H. S. Maxim. *Journal of the Society of Arts*, London, November, 30, 1894. An interesting lecture by Mr. Maxim, giving full details of his machine and experiments.

An Interview with Mr. Maxim. J. B. Smith. *The Strand Magazine*, London, December, 1894. An illustrated interview with Mr. Maxim, giving quite a full account of his various inventions and achievements.

Atmospheric Resistance. Professor W. L. Webb. *Proceedings Engineers' Club of Philadelphia*, November, 1894. An account of experiments to determine the resistance of the atmosphere to the free fall of spheres.

Progress in the Development of Flying Machines. M. MacLean. *Glasgow Philosophical Society*, December, 1894. A lecture giving an account of what has been attempted and accomplished with aviating machines.

Flying Machines. Prince Kropotkin. *The Nineteenth Century*, December, 1894. In reviewing advances in recent science, Prince Kropotkin notices the great strides made toward the solution of the aeronautical problem during the last few years.

The Aeronautical Annual. James Means. *W. B. Clarke & Co.*, Boston. 172 pp., price, $1. A compilation of some of the classics on the subject. Including extracts from Leonardo da Vinci, the essays of Sir George Cayley, of Thomas Walker, and of F. H. Wenham, the aeronautical correspondence of Franklin, some pamphlets by Mr. Means, bibliography of aeronautics, etc.

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NEW YORK, MAY, 1895.

EDITORIAL NOTES.

THE new interchange rules bid fair to become adopted, if it is any criterion to judge by the enthusiasm of those who have entered into the Chicago agreement. It is, of course, impossible to predict the recommendations that will be made to the June convention by the committee, and there will undoubtedly be a strong opposition to the throwing the responsibility for repairs upon owners, but the expense of maintaining the present system, and the continual friction that results from varied interpretations of the rules, will weigh strongly on the side of the party that is advocating the change.

IN a recent lecture before the students of Cornell University, Mr. Nixon, who was formerly Chief Constructor at Cramps, predicted that the United States was destined to become a great shipbuilding country, owing to its great ocean and lake coast, and regretted that the young men did not possess the opportunities that they should to pursue this important branch of industry. It does seem strange that, in view of the great advances which have been made in naval architecture in this country within what is almost the last decade, the colleges have not been prompt in establishing courses and endowing chairs for the naval courses.

THE reports of the runs that have been made by Admiral Meade's squadron of evolution in West Indian waters are most satisfactory to the friends of the new Navy. It appears that a maintained speed of 13 knots has been touched, which is 1 knot better than the previous performances of any squadron, while the claim is made that even a higher speed is possible. The reports also affirm that the "Pirates," the *Columbia* and *Minneapolis*, are able to hold their tactical distances easily while running at a speed of 16 knots. Such results are gratifying not only from the sense of having broken the record, but from the fact that the new Navy of the United States possesses the qualifications of speed and endurance that will render it most efficient when the occasion demands.

IT should be a matter of congratulation to those interested in technical education that the condition of affairs, as outlined by Professor Chaplin before the Engineers' Club of St. Louis, as existing in Germany has passed away in this country. It is not so very many years since the students pursuing a classical course in our colleges spoke with an air of half-pitying contempt of those taking a scientific course, as of an inferior grade of beings. But while the shoe may not be exactly upon the other foot, it does seem to be a fact that scientific courses and colleges are attracting wider public attention, and that the immediate work of these schools and colleges is considered of greater importance than that of the purely classical departments. The struggle between the two systems of education has been a long one, and the victory seems to be with the "scientifics." Doubtless the result will be the same in Germany.

OUR correspondent in Buenos Ayres writes that Captain Zalinski, who has been spending a month there and in Chili as the representative of the Bethlehem Iron Company, sailed recently on the French steamship *Portugal en route* for China and Japan. The Captain has been soliciting orders for guns and armor; and it has been particularly pleasing to Americans, and something of a revelation to the large English, French, and German contingent here, to see an American Company enter into competition with the European makers of this class of war material. Argentine field guns are Krupps and the naval (great guns) Krupp and Armstrong, most of the older ships having Armstrong's and the newer ones 4.72 in. and 6-in. Armstrong quick-firers, and when larger guns (like the 9.3-in. guns of the *Independencia* and *Libertad*) are used, Krupps. The Krupp wedge breech closure seems to be in favor here.

EIGHT-WHEELED COUPLED "GOODS" LOCOMOTIVE.

A RECENT number of *Engineering* contains engravings and a description—which are reproduced on another page—of one of the locomotives recently built by Messrs. Nielson & Co., of Glasgow, for the Mexican Railway, which recalls an acrimonious contention of forty years ago over the design of locomotives for freight service on the Baltimore & Ohio Railroad, which resembles the Mexican railway in having very long and steep grades and many sharp curves. At that time the standard freight locomotive on that line was Winans' "camel" engine, which had eight wheels coupled and no leading truck. About 1855 Mr. Henry Tyson was appointed Master of Machinery of that road, to succeed Mr. Samuel J. Hayes. Mr. Tyson was called upon to recommend a form of freight engine for service on that road. Both he and his predecessor, Mr. Hayes, had a predilection for leading trucks, and considered them essential for safety and for the prevention of undue wear to the track and flanges of the leading wheels. Mr. Winans was then engaged in the manufacture of locomotives in Baltimore, on what was then considered an extensive scale, and had supplied the Baltimore & Ohio Road with many of its engines. Naturally he was averse to having his design of engine abandoned and condemned. Besides he was of a contentious temperament

which led him to attack Mr. Tyson's opinions and decision with a good deal of acrimony in the daily papers of Baltimore, and he endeavored to excite local popular feeling, as he said, in favor of home industries. Naturally the dispute attracted much attention from people who knew nothing about locomotives. At that time the erratic Zerah Colburn was publishing the *Railroad Advocate* in New York. There was also a draftsman named John Cochran, who at that time lived in Baltimore, whose enmity Winans had in some way incurred. He and Colburn joined hands against Winans, and the pages of the *Railroad Advocate* bristled each week with denunciations of Winans and his engines. The main question under dispute, as has been intimated, was whether a leading truck was essential for safety, and for resistance to wear of the rails and wheel-flanges. Winans was very wily and ingenious and resourceful in collecting statistics, illustrations, and demonstrations to support his opinions. At the same time, John Cochran and Colburn, in nearly every number of the *Railroad Advocate*, opened their controversial guns on Winans. In the mean while, Mr. Tyson quietly addressed letters to most of the master mechanics, road foremen, and some of the more intelligent locomotive runners on the road, asking their opinion of the relative merits of Winans's "camel" and the 10-wheeled engines which had been designed and built by Mr. Hayes and his predecessors, and which were at work on the road. As the whole weight of the camel engines rested on the eight driving-wheels, they, of course, had more adhesion than the 10-wheeled engines had, a portion of whose weight was carried on a four-wheeled leading truck. The camel engines, therefore, could pull heavier trains than the 10-wheelers. The reports of the men on the road in response to Mr. Tyson's inquiry were, however, almost unanimous in favor of 10-wheeled engines. The Board of Directors sustained Mr. Tyson, and the locomotives which were then built and ordered were 10-wheelers. It must be remembered that this was before the invention of the Bissel truck, and mogul and consolidation engines did not exist then. The 10-wheeled engines built from Mr. Tyson's designs were, however, never very successful, and had some serious defects, the weight being unequally distributed on the wheels. Later, however, the road continued to build 10-wheeled engines, until they were displaced by the consolidation type.

The engraving, which is reproduced on another page, of the locomotives for the Mexican road would indicate, however, that the questions involved in this old dispute are still undetermined, and that there is yet a great difference of opinion among engineers with the most abundant opportunity for getting information and experience with reference to the question, whether a leading truck is essential for six or eight-wheeled coupled locomotives. The Mexican line is now equipped with almost every variety of truck or bogie engines, including consolidations, Fairlie, and, we believe, Johnson's plan, and yet with this evidence before them those in authority have ordered the locomotives represented by the illustrations. It will be seen from these that the rear or trailing axle is under the fire-box, and the front wheels are placed as close to the back ends of the cylinders as possible; the latter, of course, overhanging the front wheels. The question which is of interest now, as it was away back in the fifties, is whether a truck or bogie to carry and guide the front end of the engine is or is not essential? If it is an unnecessary appendage, the machine would be both simplified and cheapened by abandoning its use. It cannot be repeated too often that the main purpose of locomotives is to draw trains, and the more trains they draw, the greater is their efficiency. This function is analogous to that of a reaping machine, the main object and use of which is to cut grain when it is ripe. No matter what other advantage such a machine may have, if it cannot gather the harvest at the right time it fails of its main purpose. So with a locomotive: if it is not capable for any reason to haul cars when they are ready to be hauled, it is to that extent a failure. The question comes up, then, whether a consolidation or 12-wheeled engine will haul more cars in the course of a year than a simple eight-wheeled engine, like those the Mexican Railway Company has ordered, which is not encumbered with a leading truck? When this question was discussed by Winans and his opponents, the decision was against Winans, and it was afterward concurred in by nearly all the railroad managers in the country; and since then no engines for road service have been built here without leading trucks. It would be a singular issue of this discussion, and of the years of experience which have intervened since then, if it should appear now that Winans was right, and that the designers and builders have been attaching to all freight locomotives a useless appendage in the form of a leading truck, and that the locomotives would be more efficient and would cost less if it were omitted. At any rate, the experience of the Mexican railroad with these engines is worthy of being studied, perhaps with profit to ourselves. It should be added that the decision which was reached with so much unanimity in this country was never concurred in by European engineers, and that a large majority of freight locomotives built and used on European railroads are without leading trucks.

There were also some other interesting questions involved in the dispute between Winans and Tyson. The valve-gear on the camel engines consisted of two eccentries, with which the engine could be worked at full stroke either back or forward. The expansion gear consisted of a cam which cut off steam at about one-third of the stroke, in the forward motion only. Mr. Tyson advocated the use of a link-motion, which Winans condemned very bitterly. It is hardly necessary to say now which was right and which wrong, although it might be observed that within the past year so distinguished an engineer as Mr. Porter has proposed a cam with a fixed point of cut-off for stationary engines, so that it seems to be very difficult to be entirely certain about disputed mechanical questions.

Another feature which Winans advocated was the use of solid-end coupling-rods. Cochran and Colburn piled abuse and ridicule on this method of construction. In this it is now obvious that Winans was right and his opponents were wrong.

Another curious dispute grew out of the arrangement of Winans' engine frames and drawbars. The fire-boxes of the camel engines were made just as wide as the distance between the wheels would permit. The frames extended back only as far as the front of the fire-box. In order to connect the engine with the tender, a sort of A-shaped frame was made, which was attached to the bottom of the ash-pan, the two legs of the frame being bolted to the engine frames in front of the fire-box, and the apex was coupled to the tender drawbar back of the fire-box. This arrangement of course brought the drawbar very near to the top of the rails, and Mr. Tyson and Colburn asserted that the effect, when the engine was pulling, was to raise the back end up and thus throw more weight on the leading wheels. Winans asserted that if the drawbar was attached at a point or on a line coinciding with the top of the rails, that the tractive force of the engine would neither tend to raise nor depress the back end of the engine; or, in other words, that the neutral point or line was the top of the rails; whereas Tyson and Colburn contended that the centre of the driving-axle was the neutral line, and that the drawbar should be attached as nearly as possible in that position. We will not now say which we think was right, but will leave the question to our younger readers for discussion. It may be added, though, that this arrangement of draw-gear was miserably frail. The camel engines had a fire-box which sloped downward on top, which brought the furnace-door very low. The foot-board of the tender was made very low, so as to bring the fireman into a convenient position in relation to the

door. As the engine frames did not extend back of the front of the fire-box, there was nothing between the engine and tender to resist a concussion excepting this frail draw-gear. The foot-board and cab for the engineer was on top of the boiler, but the fireman was down behind the fire-box, where it was impossible to see impending danger. Many a poor and faithful fellow was crushed to death or, worse, was burned, scalded, or maimed in this horrible trap. The boilers, too, of the camel engines were criminally weak, and a great many of them exploded, but when this occurred, the engineer occupied the most dangerous position.

The student of locomotive design and construction will find a good deal that is interesting in the illustrations of the Mexican engines. There is nothing in the description or the drawings to indicate that the trailing wheels have end play, but the fact that the coupling-rods have spherical bearings where they are attached to the main crank-pins would suggest that the trailing axles have some lateral movement.

Another peculiarity is the tie-rods in the boiler. There is no end view to show how they are arranged, but it is inferred that they each occupy the space of one tube. The reason which led to the adoption of these rods was doubtless the difficulty of keeping the tubes from leaking. It would be interesting to know whether in this respect they are efficacious.

The valve-gear consists of an Allen straight link. Its use makes only a very slight bend of the lower eccentric-rod necessary, and not very much of a crook in the radius valve-rod where it passes over the leading axle. The distribution of steam with this form of gear is, we believe, equally as good as with other forms of link, and it has the advantages pointed out when applied to this type of engine. The valve-seat, it will be noticed, is placed vertically and on the side of the cylinder. The reluctance of English engineers to using a rocking-shaft, which would permit the valve-seat to be placed in the much more convenient position on top of the cylinders, is inexplicable to American designers. The argument against its use is, we believe, that it introduces an extra and superfluous part or organ. In reply to this it may be said that there is no working part of a locomotive which costs so little to maintain and repair as a rocker. We have no statistical data in support of the assertion, but it will probably be safe to say that the average cost of maintaining rocker-shafts in this country is not 25 cents for each per year. Then, too, we believe most American engineers would rather maintain a rocker-shaft than to lubricate and repair the sliding arrangement to which the valve-stem of the Mexican engines is attached, and which is shown in the drawings. In a rocker-shaft all the bearings are enclosed, whereas the Mexican slide is open at each end for the access of dust and escape of oil.

The plate frames and under-hung springs have advantages which we Americans are very slow to admit, but which are nevertheless obvious. In the engine illustrated they permit the fire-box to be made 6 or 8 in. wider than would be possible with our bar frames, unless the fire-box were placed on top, and then it would lose in depth.

One is disposed to wonder, though, why the "Gresham" sanding apparatus is placed in front of the main driving-wheels, and not in front of the leading wheels. With the arrangement shown only one half of the wheels are sanded.

It is hoped that after these engines get to work that the Superintendent of Machinery of the Mexican line will give the public full information of the results of their working. It will be especially interesting to know how the flanges of the leading wheels will stand service, and whether the engines are as safe and as little liable to derailment as other locomotives with trucks. If the flanges will stand the service, and if there is no more danger of derailment than there is when trucks are used, then the question may be asked, Of what good is a truck, anyway?

BOOKS RECEIVED.

Motive Powers and their Practical Selection. By Reginald Bolton. (New York: Longmans, Green & Co.)

Central American Rainfall. By Mark Walrod Harrington. Read before the Philosophical Society of Washington.

Eighth Annual Report of the Interstate Commerce Commission. December 1, 1894. (Washington: Government Printing Office.)

Indicator Diagrams and Engine and Boiler Testing. By Charles Day. (Manchester: The Technical Publishing Company, Limited.)

Screw Propellers and Marine Propulsion. By J. McKim Chase, M.E. First Edition. (New York: John Wiley & Sons, 1895.)

Annual Report of the City Engineer of the City of Omaha. December 31, 1894. Andrew Rosewater, City Engineer. (Omaha: Klopp & Bartlett Company, Printers, 1895.)

Twenty-Sixth Annual Report of the Board of Railroad Commissioners of the State of Massachusetts. January, 1895. (Boston: Wright & Potter Printing Company, State Printers.)

Professional Papers of the Corps of Royal Engineers. Vol. XX. 1894. Edited by Captain C. B. Mayne, R.E. Royal Engineers' Institute. (Agents: W. & J. Mackay & Co., Chatham.)

A Manual of Instruction for the Economical Management of Locomotives, for Locomotive Engineers and Firemen. By George H. Baker. (Chicago and New York: Rand, McNally & Co.)

Power Brakes *vs.* Hand Brakes. A Paper Presented at the Annual Convention of the American Street Railway Association, Atlanta, Ga., by Edward J. Wessels, October 19, 1894. 29 pp., $5\frac{1}{2} \times 9$ in.

Annual Report of the State Board of Arbitration and Conciliation, of the State of Massachusetts, for the Year ending December 31, 1894. (Boston: Wright & Potter Printing Company, State Printers.)

Immigration and Passenger Movement at Ports of the United States during the Year ending June 30, 1894. Report of the Chief of the Bureau of Statistics. (Washington, D. C.: Treasury Department.)

Seventh Special Report of the Commissioner of Labor. *The Slums of Baltimore, Chicago, New York, and Philadelphia.* Prepared in Compliance with a Joint Resolution of the Congress of the United States, Approved July 20, 1892. By Carroll D. Wright, Commissioner of Labor. (Washington: Government Printing Office, 1894.)

Proceedings of the Second Annual Meeting of the Society for the Promotion of Engineering Education, held in Brooklyn, N. Y., August 20–22, 1894, in Conjunction with the American Association for the Advancement of Science. Vol. II. Edited by George F. Swain, Ira O. Baker, J. B. Johnson, Committee. (Columbia, Mo.: E. W. Stephens, Printer, 1895.)

TRADE CATALOGUES.

In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. The advantages of conforming to these sizes have been recognized, not only by railroad men, but outside of railroad circles, and many engineers make a practice of immediately consigning to the waste-basket all catalogues that do not come within a very narrow margin of these standard sizes They are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues

hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.

STANDARDS:

For postal-card circulars	$3\frac{3}{8}$ in. × $6\frac{1}{8}$ in.
Pamphlets and trade catalogues	$3\frac{1}{2}$ in. × 6 in.
	6 in. × 9 in.
	9 in. × 12 in.
Specifications and letter-paper	$8\frac{1}{2}$ in. × $10\frac{3}{4}$ in.

THE NICHOLSON FILE COMPANY, of Providence, R. I., have issued a smaller edition, 60 pp., $4\frac{1}{2}$ × 6 in. [not standard size], of their larger catalogue, which was noticed in our March number.

THE GISHOLT MACHINE COMPANY, of Madison, Wis., send an eight-page circular, $5\frac{1}{4}$ × 8 in. [not standard size], containing engravings and brief descriptions of their tool grinder and turret lathe.

THE D. VAN NOSTRAND COMPANY have issued a new catalogue of 64 pp., $5\frac{3}{4}$ × $6\frac{1}{4}$ in. [not standard size], giving a list of books on Steam, Steam-Engines, Machinery, Mechanics, and Mechanical Engineering, which they publish and have for sale.

THE HURLBUT-ROGERS MACHINE COMPANY, of South Sudbury, Mass., send a four-page leaflet, $5\frac{3}{4}$ × $9\frac{1}{4}$ in. [not standard size], describing and illustrating their cutting-off machines. The circular contains excellent wood-engravings of their machines.

THE SHORTT ENGINE COMPANY, of 143 Liberty Street, New York, publish a pamphlet of 12 pp., $4\frac{1}{2}$ × $7\frac{1}{4}$ in. [not standard size], in which a somewhat peculiar form of boiler and engine is described. It would be impossible to describe the construction of these without engravings so that they could be understood.

THE DE WITT WIRE CLOTH COMPANY, of 32 Reade Street, New York, send their price-list No. 54, which contains 24 pp., $3\frac{3}{8}$ × $6\frac{1}{4}$ in. [not standard size], in which illustrations and prices are given of wire nettings of different kinds, wire fencing, gates, wire cables for lightning-rods and fencing, and wire cloth for various purposes.

CAST-IRON CHILLED CAR WHEELS. 37 pp., $4\frac{1}{2}$ × $5\frac{3}{4}$ in. [not standard size]. This little publication is issued by the Association of Manufacturers of Chilled Car Wheels, and sets forth an account of the history and use of chilled wheels, and of the negotiations with the Master Car-Builders and Master Mechanics Associations, and the adoption of standard specifications and form of guarantee for cast-iron wheels.

PATENT STORAGE HEATERS FOR RAILWAY CARRIAGES. Illustrated Catalogue, with Detailed Explanation. W. S. Laycock, Victoria Street Works, Sheffield, and 91 Queen Victoria Street, London.

This pamphlet contains illustrations and descriptions of the Gold car-heater which Mr. Laycock is introducing on English roads. It requires no description here, as most of our readers are familiar with this system.

CATALOGUE NO. 3, RIEHLE BROTHERS TESTING MACHINE COMPANY, Philadelphia, 95 pp., $9\frac{3}{8}$ × 12 in. [nearly a standard size]. This is a new edition of the catalogue published by this well-known Company, which has so long been engaged in the manufacture of testing machines. A great variety of them are described and illustrated. This new edition contains some additional matter which has been added to earlier catalogues and new names of parties using the machines of the Company.

THE ADAMS BOILER COMPANY, of Cleveland, O., have published a 12-page pamphlet, 5 × 8 in. [not standard size], describing the Adams feed-water heater and purifier, which is illustrated by two engravings, one an external and the other a sectional view. There are no letters of reference on these engravings nor in the description, so that the latter is not easy to understand. Of course, this deficiency in the catalogue does not imply that the heater and purifier is not all that it is represented to be.

THE PRINCE MANUFACTURING COMPANY, of 71 Maiden Lane, New York, have issued a pamphlet of 32 pp., $5\frac{3}{4}$ × 9 in. [not quite standard size], on The Rusting of Iron and Steel, How it May be Prevented and How it is Promoted, in which the virtues and merits of the Metallic Paint which this Company manufactures is set forth. An interesting feature is some engravings made from photographs showing black iron oxide scale produced by painting the hull of an iron steamboat with another kind of paint.

THE Q. & C. COMPANY, of Chicago, send us a catalogue of 24 pp., 6 × 9 in. [standard size], illustrating five different designs of cold metal-sawing machines and grinding machines for saw blades which they manufacture. These are illustrated with somewhat indifferent engravings, and are fully described. Probably, though, the efficiency of the saws will not be affected by the character of the engravings. The prospective buyer can get the information he wants from the publication before us, and that is what it was intended for.

MURRAY & TREGURTHA, of South Boston, Mass., have issued a catalogue of 40 pp., $5\frac{3}{4}$ × 9 in. [not standard size], in which the steam yachts and launches, Tregurtha water-tube boilers, single, compound, triple, and quadruple marine engines, propeller wheels, etc., are described. It is illustrated with a number of good wood-engravings and half-tone illustrations of their launches, boats, boilers, etc. The latter are described at considerable length, and their advantages set forth. A number of small vertical, simple, and compound engines, steam pumps, and engine and boiler attachments are also shown.

THE ST. LOUIS IRON & MACHINE WORKS send us two catalogues, both $5\frac{3}{4}$ × $8\frac{3}{4}$ in. [not standard size], one of them, of 42 pp., describing the St. Louis Corliss engine manufactured by this Company. Very good wood-engravings are given illustrating a simple, a tandem, a cross compound engine, and a "heavy duty" simple engine for rolling mills, etc. Detailed illustrations and descriptions are also given of the different parts of the engines, such as the pillow-block, cylinders, pistons, cross-heads, connecting-rods, fly-wheels, etc.

The second catalogue contains 22 pp., and describes the Improved Lion Brick Machine, which is built by this Company. A very simple form of slide-valve engine is also illustrated.

THE FIRE-PROOF BAKER CAR-HEATER. Manufactured by William C. Baker, 143 Liberty Street, New York.

This is an eight-page folder $8\frac{1}{2}$ × $10\frac{3}{4}$ in. [standard size], in which Mr. Baker's fire-proof car-heater of 1895 is illustrated by excellent wood-engravings. The heater is encased in a shell made of boiler steel capable of being bent and folded in close folds without cracking, as is shown by an illustration of sample which has been so treated. This shell is "firmly welded into one compact, jointless and seamless whole, which can be bent and buckled but never broken," and it is claimed that fire inside of it is as secure as it would be if enclosed in an express car safe. Further security is obtained by the use of sliding doors securely fastened, and by bolting the heater with strong bolts and brackets to the floor instead of fastening it with wood-screws or not at all.

The Baker heater, as most of our readers will know, has a coil of pipe in the inside, through which water circulates and is carried through the car by pipes near the floor. This gives a uniform and very agreeable heat. Explosions are guarded against by the use of Mr. Baker's safety vent, which was illustrated in the AMERICAN ENGINEER for July, 1894, and is shown in the circular before us.

MORISON SUSPENSION FURNACES. Manufactured by the Continental Iron Works, Brooklyn, N. Y. 24 pp., $8\frac{3}{4}$ × 11 in. [Not standard size.]

The furnace which is described in this publication is similar to the well-known Fox corrugated furnace, which has been so extensively used in Europe and to a more limited extent in this country. The illustrations are a frontispiece on the title-page representing an external view of one of these furnaces; a full-sized section showing one of the corrugations; sectional views representing different types of the furnace method of flanging, arrangement in groups, etc.; and sectional views of land boilers, with single and double furnaces, and finally illustrations of the Morison patent furnace door and frame. A partial list of steamers to which Morison suspension furnaces have been applied occupies several pages of the book, which is well printed and illustrated. The deficiency in it is that the distinctive features of the Morison furnace are not fully enough explained. The reader, after finishing the description

on page 5, has no distinct idea of the difference between the old Fox furnace and the Morison form of construction, nor wherein the advantage of the latter consists. A fuller explanation of the objects aimed at and accomplished by the new form of furnace would, it is thought, make the book more useful to its readers and publisher.

The Ferracute Machine Company, of Bridgeton, N. J., have issued a new catalogue of their presses, dies, etc., which they make. The size of the cover of the catalogue is 7 × 10 in. [not standard size], and the leaves inside are of nearly double these dimensions, and have the peculiarity that they are all folded so as to be housed, as it were, inside of the cover. This gives a page 12¾ × 9¾ in. On the title-page it is stated that over 300 sizes and kinds of presses are described in the catalogue. These consist chiefly of presses and dies for the shearing, cutting, punching, bending, forming, embossing, coining, drawing, deepening, broaching, etc., of bar and sheet metals, together with paper, leather, cloth, and other materials. A few auxiliary tools, such as spinning lathes, beading machines, soldering apparatus, etc., are also made. The engravings are generally excellent wood-cuts, but there are also some half-tone engravings which are not so good, partly because they are not well printed. Blue ink is used, the reason for which is not apparent. It does not improve the appearance of the pages nor add to the effectiveness of the illustrations, and we are inclined to think is unsuited for half-tone work. Presses for doing a great variety of work are illustrated, and it would seem as though this Company was prepared to squeeze almost anything.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.

SECOND SERIES.—CHEMICAL METHODS.

XIV.—METHOD OF DETERMINING FLASHING AND BURNING-POINTS OF COMBUSTIBLE LIQUIDS.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(*Continued from page* 75.)

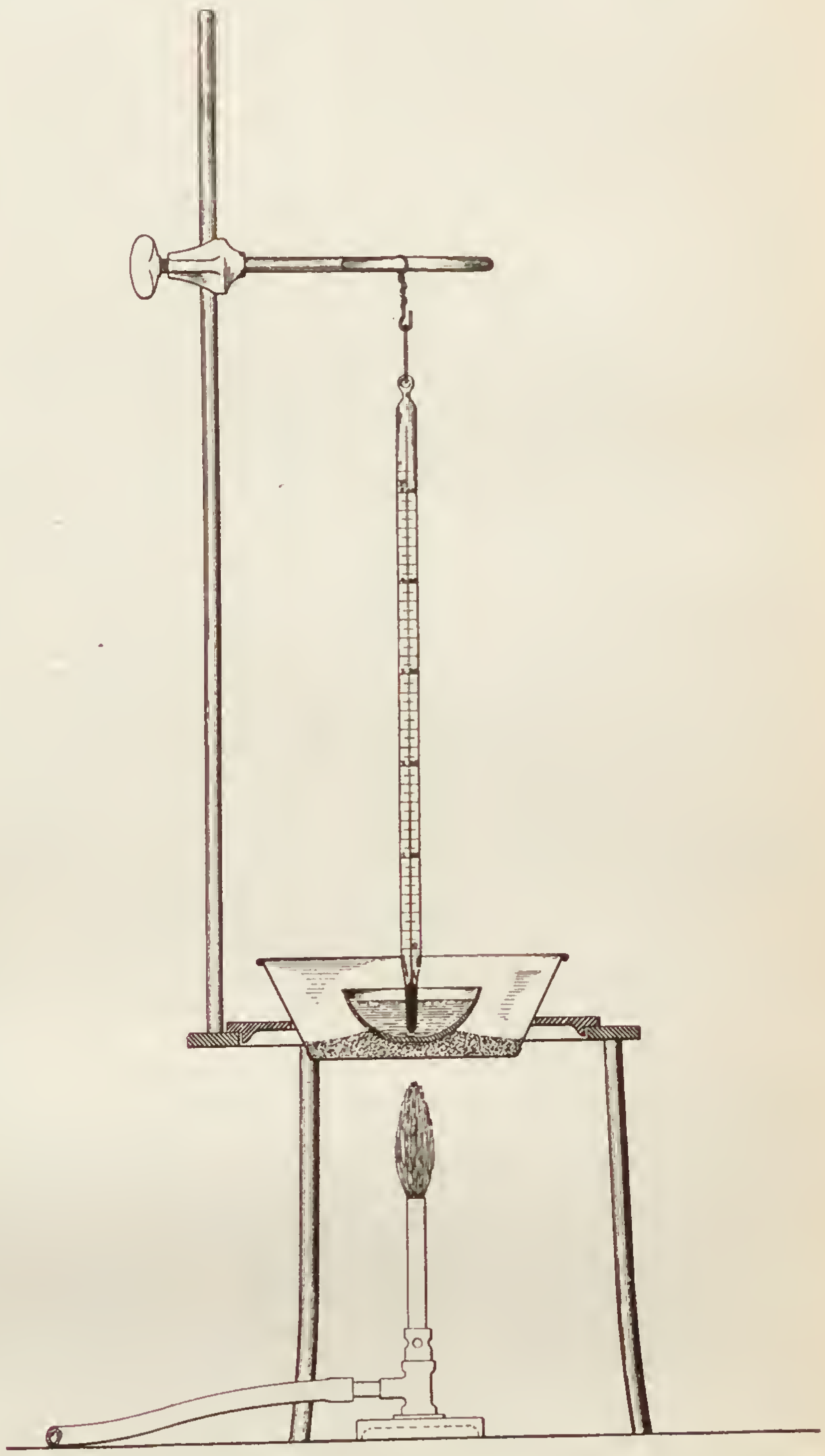
OPERATION.

Have ready the apparatus shown in the cut. Light the lamp, put it under the centre of the porcelain dish, adjust it as previous experience has indicated is necessary to secure the proper rate of heating, and allow the apparatus to get warm. Fill the porcelain dish to within about one-fourth of an inch of the top with the liquid to be tested, adjust the thermometer in the centre of the liquid, and so as to reach nearly to the bottom of it, but not quite touching the dish. Adjust the flame so that the temperature of the liquid in the dish rises at the rate required for the liquid being tested, and when the temperature reaches a desired point, apply the test flame by passing it slowly, entirely across the dish, about half an inch above the level of the liquid and just in front of the thermometer. Allow the liquid to rise in temperature until another testing point is reached, and then apply the test flame again in the same manner. Proceed in this way until the vapor from the liquid above it ignites with a slight flash. The temperature shown by the thermometer when this is the case is the flashing point of the liquid. Continue the heating and testing in the same manner until a point is reached where the liquid takes fire. The reading of the thermometer when this is the case is the burning-point of the liquid. Remove the thermometer, blow out the flame, or smother it by sliding a watch glass over the top of the porcelain dish, empty the dish and wipe it out, when the apparatus is ready for another test.

APPARATUS.

The principal portion of the apparatus required in determining the flashing and burning-points is shown in the cut. It consists, as is seen, of an iron tripod, fitted with a rod and clamp to sustain the thermometer, and supporting a small pan or dish partly filled with sand. On the sand and partly bedded in it is a royal Berlin porcelain dish about 2¾ in. in diameter and 1 in. deep, to hold the liquid to be tested. Underneath the iron dish is a Bunsen burner to furnish heat. The thermometer may be any good chemical thermometer, but those with milk or paper scale, and graduated to single degrees, are easiest read.

The testing flame may be obtained in a variety of ways. A fine string or coarse thread was used for many years. This, when lighted, gives a bead of flame as large as a small pea. A glass tube drawn out to rather a fine jet and connected by a rubber hose with a gas supply is much better.



APPARATUS FOR DETERMINING THE FLASHING AND BURNING POINTS OF COMBUSTIBLE LIQUIDS.

The flow of gas can readily be adjusted to give a jet about ¼ in. long and ⅛ in. in diameter, which is abundant in size. The glass tube fuses up sooner or later, and therefore best of all is a porcelain tube, such as is used with crucibles for ignition in hydrogen, attached by a rubber tube to a gas supply. The flame should be of the size given above.

NOTES AND PRECAUTIONS.

The philosophy of the method of taking flashing and burning points of combustible liquids is simple. All liquids when heated to sufficient temperature give off vapors, the vapor being either a part of the liquid itself or the products of decomposition from it. Moreover, most liquids whose flashing and burning-points are desired, notably the petroleum products, contain some constituents which are volatile at lower temperatures and some which are volatile at higher temperatures, so that when heated by a constantly increasing temper-

ature vapors pass off in constantly greater amount. The process being conducted in the air, the vapors passing off from the liquid obviously mix with the air above it, and in course of time, if the heating is properly managed, a slightly explosive mixture of vapor and air exists just above the liquid. If, now, a flame is passed through this explosive mixture it is ignited, and a more or less violent explosion, or "flash," as it is called, follows. The lowest temperature at which enough vapor escapes from the liquid to form this explosive mixture is called the flashing-point of the liquid. In like manner, by continuing the heating and raising the temperature higher and higher, the amount of vapor issuing from the surface of the liquid becomes continually greater and greater, and the explosions become more and more frequent if the test flame is applied often enough, until finally the amount of vapor above the liquid becomes so great that it will take fire and burn continuously. The lowest temperature at which this takes place is called the burning-point of the liquid. It is obvious, therefore, that any conditions which have an influence on the generation of vapor from combustible liquids, or which have an influence on the mixing of this vapor with the surrounding air, or which influences its dissipation from the surface of the liquid, will have an influence on the flashing and burning-points of the liquid. It is also obvious that the apparatus used and the method of manipulation will have an influence on the figures obtained, so that the flashing and burning points of any given sample of combustible liquid, obtained by means of one apparatus and method of manipulation, will not necessarily be the same as that obtained by means of a different apparatus and a different method of manipulation, even on the same sample of liquid.

The condition which has the most influence on the flashing and burning-points of combustible liquids is the rate of heating the liquid, and this is at the same time the most difficult condition to control. The more rapid the rate of heating, the lower the flashing and burning-points, and in view of the principles given above, it is easy to see why this should be so. Obviously a liquid could be heated so slowly that the vapor formed would for a long time pass off into the air by diffusion, and the amount necessary to indicate the flashing and burning-points be obtained only with much higher temperature. On the other hand, a liquid can be heated so rapidly that the flashing and burning-points are practically the same, and these many degrees below the figures obtained by slower heating. The rate of heating used in the Pennsylvania Railroad Laboratory is as follows:

For 150° fire-test petroleum,	12° F.	per minute.
" 300° " "	15° F.	" "
" paraffine oil,	15° F.	" "
" well oil,	15° F.	" "
" 500° fire-test petroleum,	15° F.	" "
" wood preservative,	12° F.	" "

For all other combustible liquids of high burning-point, 15° F. per minute.

The adjustment of the rate of heating can best be learned by experience and constant watching of the thermometer. If the amount of sand in the dish is moderately large, and the temperature of the room constant, and the place where the tests are made free from drafts, the flame can be adjusted after some experience so as to give a close approximation to the required rise in temperature. But the thermometer must, of course, be constantly watched, and it is many times necessary to repeat a test even two or three times with readjustment of the flame on account of failure to secure the proper rate of heating. Moreover, each time the liquid is flashed a small amount of heat is generated, which affects the thermometer, and if the flashing is done very frequently this may be a very serious cause of disturbance of the rate of heating. The lower the flashing and burning points of the liquid being tested, the more difficult the manipulation to secure the required rate of heating.

In view of the difficulties introduced by frequent flashing, it is advisable to limit the number of times the test flame is applied as much as possible, and accordingly in the Pennsylvania Railroad Laboratory the test flame is first applied as follows:

For 150° fire-test petroleum,	at 123° F.
" 300° " "	" 242° F.
" paraffine oil,	" 291° F.
" well oil,	" 242° F.
" 500° fire-test petroleum,	" 487° F.
" wood preservative,	" 165° F.

In all cases after the first the test flame is applied after each 7° rise in temperature, until the burning-point is reached. This is in accordance with an old law of the State of Pennsylvania, enacted in the early days of the petroleum industry.

The method of applying the test flame has an important influence. By skilfully and adroitly passing the test flame down alongside the thermometer to within ¼ in. of the liquid and quickly pulling it out again, considerably higher figures may be obtained for the flashing and burning-points than with the manipulation specified. Apparently near the centre of the dish, alongside the thermometer, the air and vapor are not as well mixed, or at least are not in condition to ignite as readily as at the side of the dish. By the prescribed manipulation the chances for juggling with the results are diminished, since the test flame passes twice through that part of the mixture of vapor and air which is most readily ignited—namely, the part at the edges of the dish.

It is impossible to make satisfactory tests for flashing and burning-points in a place subject to drafts.

Among the variables affecting the flashing and burning-points of combustible liquids, which are made constants by the apparatus specified above, may be mentioned the amount of surface exposed, the depth of liquid in the dish, and the total amount of liquid. Any or all of these being different, the same figures would not be expected, even though the manipulation was in every respect as specified. Moreover, a difference of an inch or more in the barometric pressure, which might readily occur in different parts of the country, would also have an influence on the figures obtained, the lower barometer giving the lower figures.

It is well known that thermometers change with use, especially if they are not well seasoned before going into service. It is essential, therefore, to occasionally compare with a standard, or to use new thermometers.

Occasionally an anomalous low fire-test petroleum product will be found. The flashing and burning-points are very close together, whatever the rate of heating. Apparently the liquid is very closely fractionated, or is made up of constituents differing very slightly in vaporizing point, and consequently its behavior does not conform to that characteristic of liquids having a wider range of constituents.

It is fair to say that open-cup testing of combustible liquids, even when all possible precautions are taken, is subject to some uncertainties. Duplicate tests with the same liquid, the same apparatus, and the same manipulator may disagree one point, or 7°, and an attempt to get duplicate figures, representing the flashing and burning-points of a liquid as close as 1 or 2° F., would probably result in failure.

ELECTRIC WEED-KILLER.

Mr. A. A. Sharp has been experimenting for sometime with an electric weed-killer for railroad work. In reply to inquiries we have received the following letter from the electrician in charge of the technical development of the apparatus

Editor of The American Engineer and Railroad Journal

I beg to state that the apparatus used by us consists of an alternating generator mounted on a car and producing electricity at 2,000 volts pressure and stepped up to from 6,000 to 24,000 volts, depending on the kind and quality of the vegetation which we wish to destroy.

The conductivity of vegetable bodies varies as the moisture within them varies; the greater the moisture, the less resistance they offer to the current. The current, after being stepped up to the voltage noted, is conducted through a series of fine wire or brush to the top of the weeds or grass; the other side of the circuit is made through the wheels of the car as a matter of course to the ground; the current, therefore, will leap from the brush suspended over the weeds through the weeds to the ground, and thus complete the circuit; but in doing so the current traverses the entire length of the plant, including the roots, and ruptures the cellular tissues, thereby totally destroying it. This destruction seems to be equally distributed throughout the entire system, the root suffering perhaps more than the body of it from the fact that the roots generally contain more moisture. In many cases the current, in passing through the plant, heats it to such an extent that it cannot be held in the hand without discomfort.

The device is entirely practical; and I am satisfied that Captain Sharp has made a discovery which will be of infinite value in connection with the destruction of noxious weeds, the Canadian and Russian thistle, cockle burrs and the like. It is especially valuable in the destruction of plants such as the thistle, where the root itself must be destroyed in order to annihilate the weed.

The device is of great value in the destruction of grass and weeds along the railroad, where the maintenance of the right of way is decreased to the extent of from $40 to $80 per year

per mile; and I believe, in connection with the work of exterminating the Russian thistle and such like noxious weeds, it will prove to be of great benefit.

The apparatus can be made quickly and at no very great expense. During the coming summer there will be ample chance for you to see the machine in practical operation, and it would give the writer great pleasure to have you accompany us on one of our trips. I trust this will give you some insight into the application of this machine.

CHARLES G. ARMSTRONG.

ELECTRIC MOTORS AT THE SOUTHWARK FOUNDRY & MACHINE COMPANY'S SHOPS.

WHILE the discussions relative to the advisability of using electric motors for driving machine tools has been in progress, and while the comparative merits of the *pros* and *cons* have not been settled, the Southwark Foundry & Machine Company have found by stress of circumstances that it has been almost necessary for them to adopt an extensive system of electric motor driving for doing a wide range of work in their shops. It is well known that the specialty of this establishment consists in the construction of what is known under the general name of heavy work. This work covers so wide a range that none, or at least very little of it, can be done by tools built especially for the purpose, and they are, therefore, compelled to depend upon the ordinary standard tools to execute it.

As the handling and setting of this work would involve a great amount of labor were it to be carried to the machine, it has been found to be more economical in many instances to carry the machine to the work, and for this purpose a number of small machines have been designed and built that can be clamped to the work, the latter really acting as the bedplate for the tool. Besides greatly facilitating the work, this method possesses the further advantage of enabling certain parts, such as bedplates of engines and the like, to be cast in one piece; whereas, were it necessary to do the machine work upon some regularly appointed tool in the shop, it might be necessary to cast it in two or more pieces that it might be brought within the range of the capacity of that tool, besides requiring more machine work to be done in order to fit the two parts together.

As the adaptability of the electric motor to this class of work was demonstrated to be a success, it was applied to other fixed tools in the machine shop, where there is a very heavy four-headed planer, built by the William Sellers Company, driven by an individual motor, and beside it there is a large facing miller driven in the same manner. In the case of the latter, the advantages derived from the use of the motor are very apparent. The head and all of the machinery, including the motor, travels over the ways, while the work is bolted to a heavy bedplate and is stationary. A fixed screw in the base beneath the head is the point to which the power for propulsion is applied. As the motor is bolted to a bracket on the head or frame of the machine, it has been unnecessary to make any provision for the variation of the point of application of the power, and the single belt that covers with its many bendings all of the pulleys to which motion must be imparted, suffices. This machine is used for facing wide surfaces, such as the feet of engine frames, and is, of course, far more rapid in the execution of its work than a planer.

The erecting shop is also equipped with two 50-ton electric cranes that are in constant service, handling not only the heavy work itself, but lending efficient aid in the setting and adjustment of the portable tools, which are sometimes very heavy in themselves. Indeed, one of the portable machines was not built for portability, but is an exceedingly well and substantially built radial drill that is at times hoisted to the top of large machinery in course of erection, and, driven by an electric motor, is made to do its work, while, were it bolted to a suitable foundation on the floor, it would be absolutely impossible to utilize it for this class of operations.

Among the almost innumerable applications of these motors, we can only mention a few of the more noteworthy and prominent. At the present time there are in course of erection at the shops four triple expansion engines for the Philadelphia Water Works. As the parts of these engines are exceedingly heavy and bulky, portable machines have been used for doing a large portion of the heavier work; the main crank bearings on the bedplate have been bored out by a specially designed boring bar driven by an electric motor; the cranks are bored for the pins by a boring machine clamped to the body of the crank-shaft and driven by a motor on the floor; a great deal of slotting is done by special slotting devices, while it goes without saying that all of the drilling on the heavier portions is done by portable drills that are driven by individual motors, this having been found to be more expeditious and convenient than the old-fashioned rope drive with which all are familiar. In the case of these engines, too, the motor is utilized for driving a train of gearing by means of which the engines are turned over after erection for the purposes of valve setting and such other work as may require this to be done. In fact, the impression obtained is that small tools are amply sufficient for performing the major portion of the machine work on these very large jobs.

There is still another general application that is easily imitated, and one which, we believe, will meet with a cordial reception; it is a lathe-grinding tool. The trouble with all lathe-grinding attachments that have been heretofore in use is that the length of the overhead drum limits the length that can be ground, and determines the exact place where it must be done. At the Southwark shops the emery wheel fixture is bolted to the lathe carriage in the ordinary way; a couple of pieces of timber are also bolted on and left to project out to the front 5 or 6 ft. The motor is placed on these and belted direct to the wheel shaft. So the power travels with the carriage, the drum is entirely dispensed with, and the work can be done at any point along the length of the bed.

Hydraulic jacks, crank presses, valve bushing insertions are all operated by these portable machines, and, indeed, it would be difficult to mention an application which it has not found.

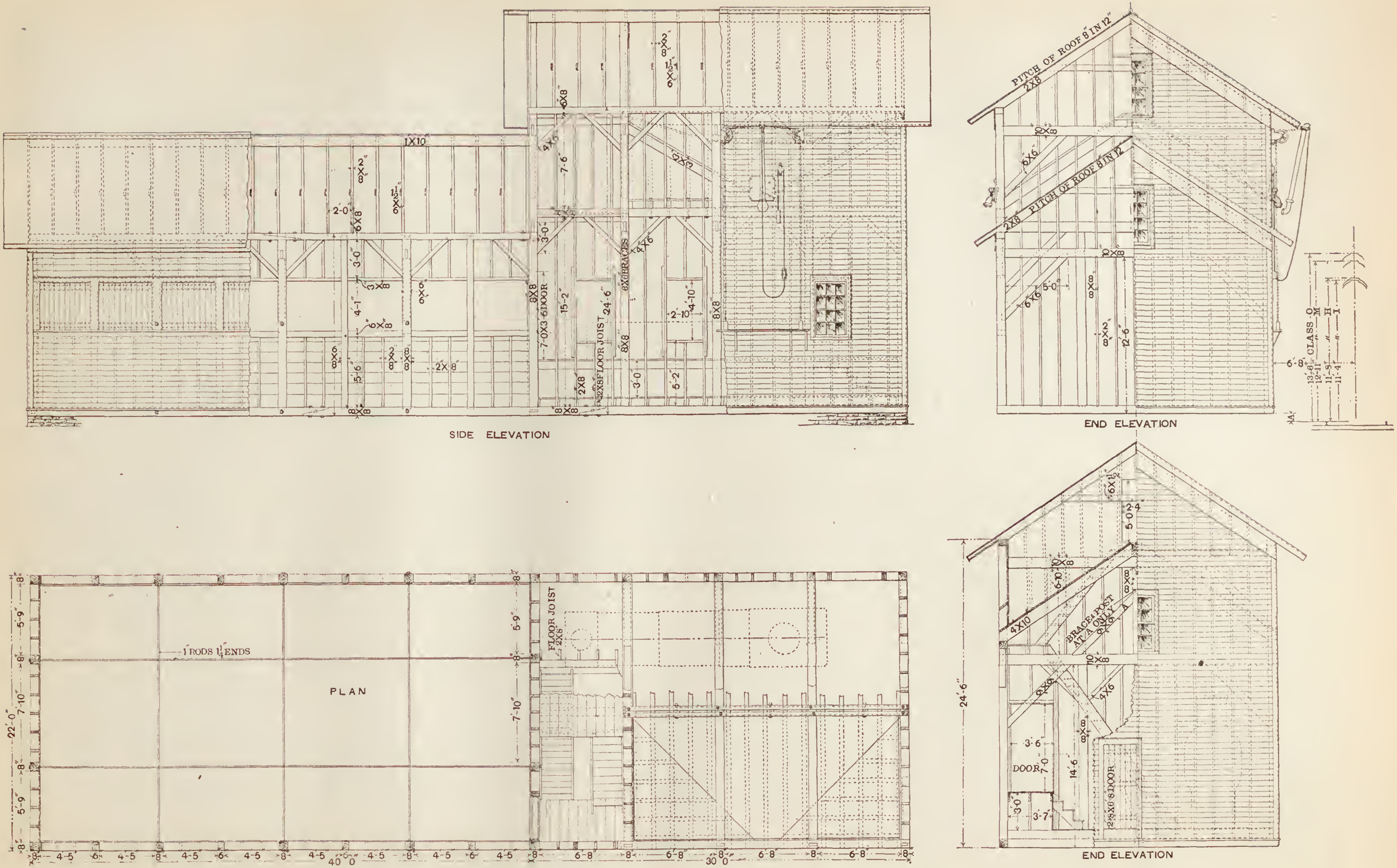
The motors used average about 3 H.P. and are connected by insulated wires strung to switches located at convenient points about the shop. No pains are taken to fasten the motors while they are at work, as their own weight is amply sufficient to hold them in position and keep the belt tight. The unfortunate part of the matter is that the installation is, like the Irishman's wife, regarded as a "rale convanyence," without any reference as to cost of maintenance. There are no figures available under this head. The power for the dynamo is taken from the main line of shafting, and so goes in with the general cost of power, without the slightest attempt being made or being likely to be made to separate it. The reason is very simple: the motors work so satisfactorily and effect such evident savings in the cost of manufacturing that even though their efficiency might be found to be below the lowest figures that any one would presume to give them, the savings would still be found to be far in excess of any wastefulness in the consumption of power that they might be found to develop.

SAND-SHED AT HORNELLSVILLE—NEW YORK, LAKE ERIE & WESTERN RAILROAD.

SOME months ago there was completed at the Hornellsville shops of the New York, Lake Erie & Western Railroad a sand storage and drying shed that is remarkably complete in all of its details, an engraving of which is given on the opposite page. The total length of the whole building is 70 ft., 40 ft. being utilized for the storage of wet sand, and shown at the left-hand end of the engravings of the elevation and plan. It consists merely of a large covered building with doors opening between the uprights, placed at a height of 6 ft. above the sills, and through which the sand is unloaded from the cars. The main building at the right is devoted entirely to the drying, elevating, and storing of the sand ready for delivery to the locomotives. While the officers modestly assert that the sand shed proper was not originally designed with a view to the most modern methods of drying and elevating sand, it certainly appears to the lay mind that they have succeeded in constructing a building and plant that is admirably adapted to the purpose for which it is intended, and one that handles a large quantity of material with economy and ease.

The sand is brought in from the storage shed by means of a trolley, from which is suspended a hopper-shaped bucket holding about 400 lbs. of sand. This is filled and brought to the dryer, where it is raised by means of an air-hoist to an elevation above the dryer, and put upon a track running over the latter, and on which the bucket can be run to any desired point over the dryer and dumped.

The dryer is so designed that no sand which is not thoroughly dried can pass out through the ½-in. slot that runs along the entire length of its lowest extremity. This is accomplished by means of a convex shield that is placed directly over the lowest steam-pipe and extends out to within ¾ in. of the sloping sides, where it retards the flow of the wet sand until it is dried sufficiently to run over this shield. The drying is accomplished by a number of rows of steam-pipes that run the entire length of the drying bin and furnish ample heat to thoroughly dry the sand. Steam for this purpose is furnished by a locomotive form boiler, whose location is indicated by the dotted lines in the lower right-hand corner of



SAND-SHED AT HORNELLSVILLE—NEW YORK, LAKE ERIE & WESTERN RAILROAD.

one of the end elevations. It also provides the steam for an 8-in. Westinghouse air-pump, which in turn provides the compressed air for elevating the dried sand.

When the dried sand runs down through the slot it first passes through a fine screen, which is stretched over the sloping channel, and is then carried by gravity down into the mouth of a funnel, whence it passes directly into a blast-pipe, and is blown by the current of air coming from the air-pump into the storage bins above. In order that the amount of sand elevated may be regulated in proportion to that required, the portion below the bins is divided into three sections, each having its own independent hopper and pipe. This also enables one of the pipes to be shut down for repairs without stopping the whole plant or disturbing either of the others. When this is done the air pressure is increased in the two remaining sections, and nearly as much work is done with the two at such times as with the three when working under the normal pressure of 25 lbs. per square inch, showing that the actual capacity of the plant is considerably above that at which it is rated, which is an average of 14 tons of sand per day dried, and elevated to the storage bins, or enough to supply from 60 to 70 locomotives.

The storage bins into which the dry sand is elevated are at a sufficient height, so that it will flow into the sand-boxes of the locomotives by gravity. The upper end elevation of the building shows the line of rails running alongside the building with the heights of the tops of the sand-boxes of several of the classes of locomotives that are in use upon the road. A spout like that ordinarily used for water enables the fireman to take on sand in exactly the same way that he usually fills the tank with water and with a minimum of time, while the cost for labor is practically reduced to nothing.

Referring to the details of the sand-bin as shown in figs. 1 and 2 they will require but a brief explanation. In fig. 1 is seen a side and end elevation with a plan and cross-section of the threefold dryer. This dryer is 20 ft. long, and occupies half the length of the drying portion of the building. The sand, after being dried by the heat of the steam pipes as already described, drops through the slot in the bottom, and running down the inclines, flows into the funnel *B* through the strainer netting *C*. This latter is made of wire with six meshes to the inch, and is readily taken out for cleaning. The funnel *B* is made of galvanized iron, and is of the dimensions given in fig. 2. The action of the air blast will be easily understood by referring to the end elevation in fig. 1. The sand flows out of the bottom of the funnel *B* and through the curved pipe into a tee, into the bottom of which the air nozzle *A* is screwed. Here it meets the air blast and is carried up the 1¼-in. discharge pipe to the hopper above.

The section *E* in fig. 2 is drawn through the outlet from the storage bin. The section shows the disk valve open for the

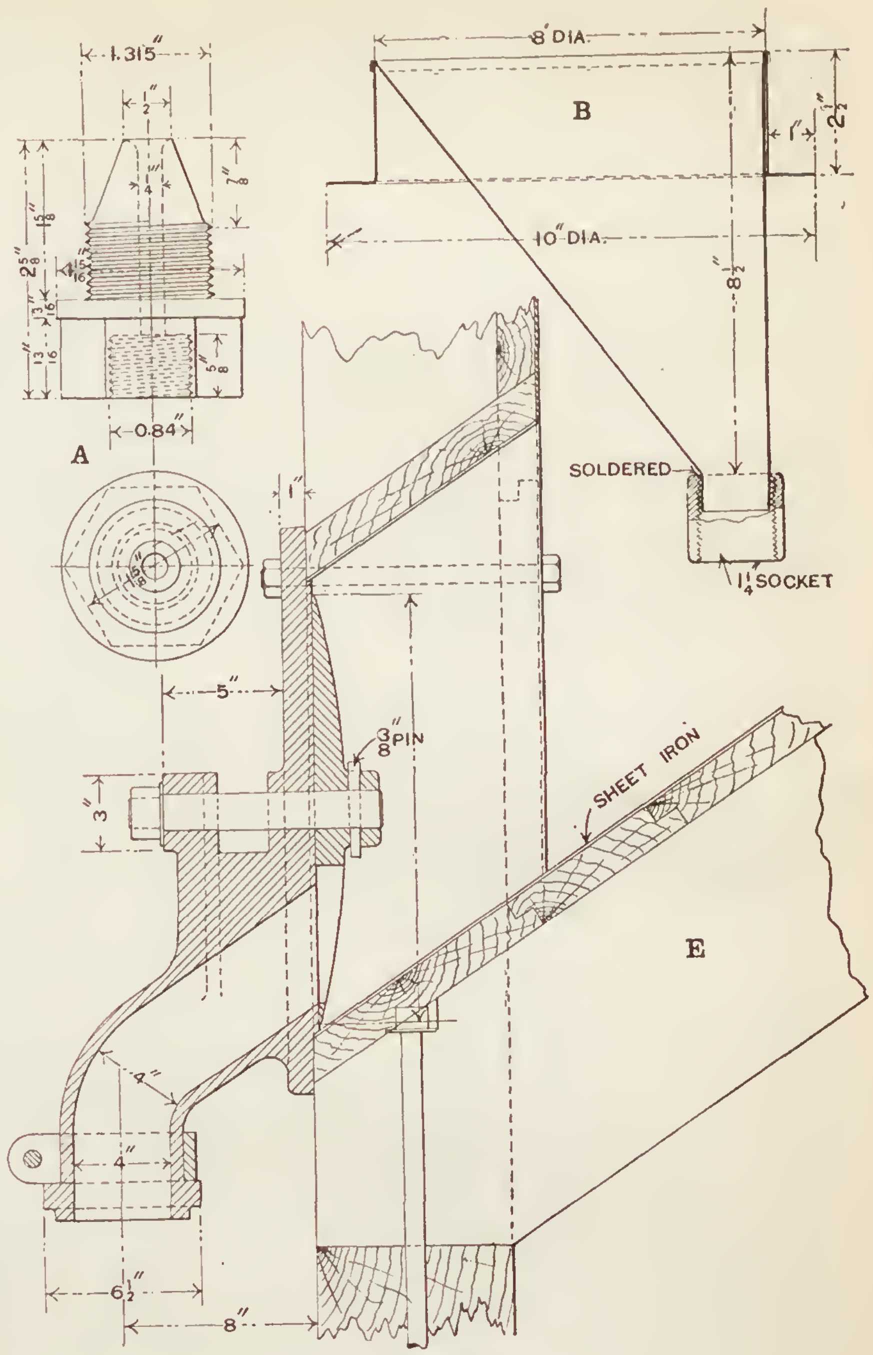


Fig. 2.

DETAILS OF HORNELLSVILLE SAND-SHED—NEW YORK, LAKE ERIE & WESTERN RAILROAD.

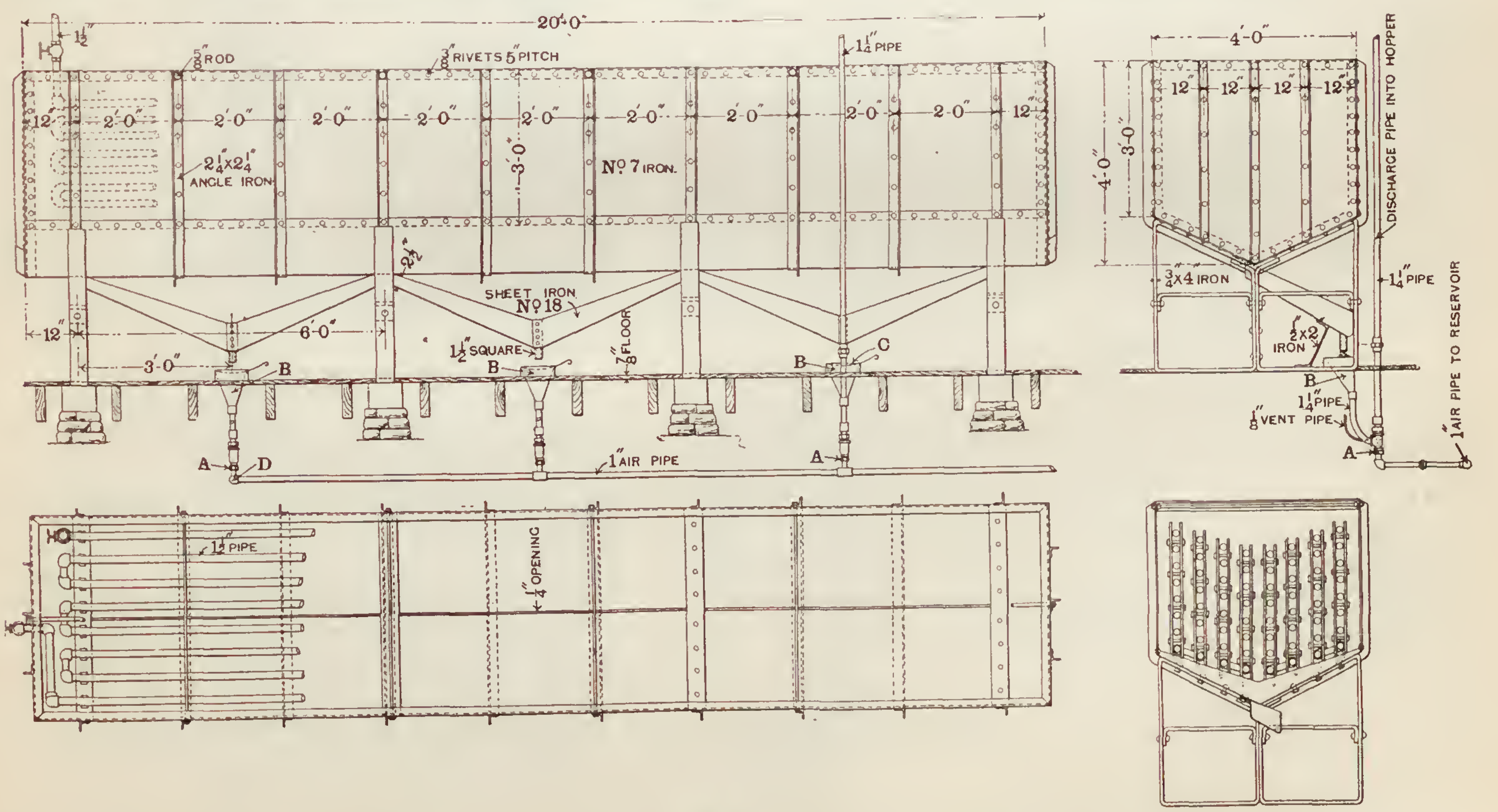
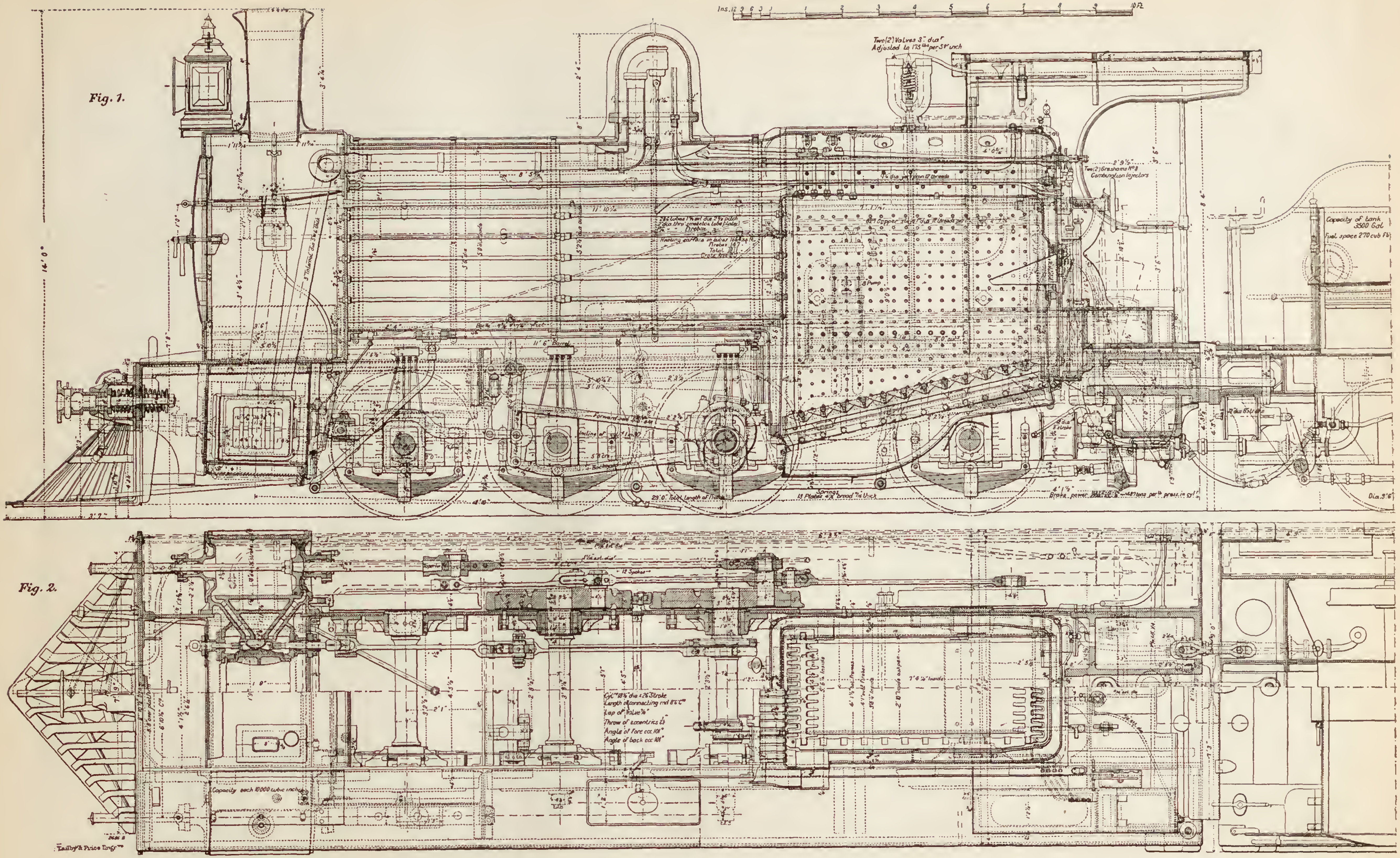


Fig. 1.

SAND-DRYER, HORNELLSVILLE SAND-SHED—NEW YORK, LAKE ERIE & WESTERN RAILROAD.



EIGHT-WHEELED COUPLED FREIGHT LOCOMOTIVE FOR THE MEXICAN RAILWAY.

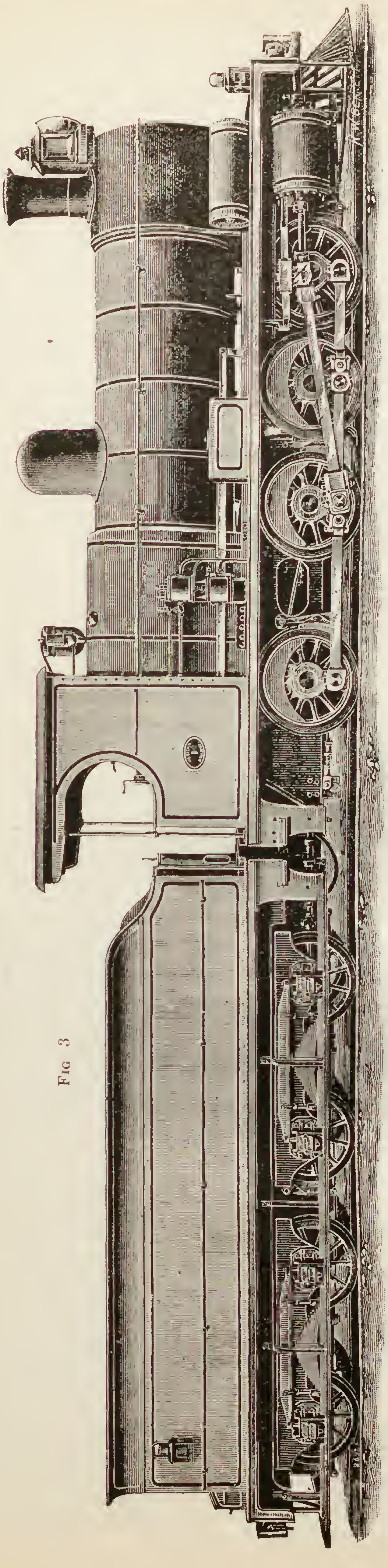


Fig 3

EIGHT-WHEELED COUPLED FREIGHT LOCOMOTIVE FOR THE MEXICAN RAILWAY.

flow of sand, but a pull upon the lever attached to the stem of the same in the opening shown in the casting on the outside of the building will give the valve a quarter turn and shut off the flow of sand. All working parts are readily accessible for repairs, and their dimensions are fully given on the engravings.

The whole plant is so complete and must effect such a marked saving, not only in the amount of sand used, but in the cost of labor in handling and drying, that it cannot fail to commend itself to all superintendents of motive power and master mechanics whose divisions employ locomotives enough to warrant the original outlay, which, in the case of so simple a structure as this, seems to have been reduced to a minimum. The only point of criticism which can be offered is the use of the Westinghouse pump for air compressing, which no one claims to be an economical steam user. The substitution of a regular compressor might effect a slight saving of coal, but in view of the familiarity of railroad employés with this pump, and the naturalness with which an extra one is slipped into any convenient nook where it can be used, the criticism will necessarily be without much force. The main fact is that the plant is exceedingly convenient and economical.

FREIGHT ENGINE FOR THE MEXICAN RAILWAY

In the accompanying illustrations we show one of the freight engines built by Messrs. Nelson & Co., of the Hyde Park Locomotive Works, Glasgow, for the Mexican Railway, the specifications being prepared by Sir A. M. Rendel, the Consulting Engineer for the line. The service that the locomotive will be called upon to perform will be over many miles of track where the gradient is steeper than 1 in 30; hence even a light train necessitates the use of a powerful engine. The engine illustrated has cylinders 18½ in. in diameter and 26 in. stroke. The wheels, which are eight-coupled, are, however, but 4 ft. in diameter over treads, so that the tractive force is very high. Unlike the passenger locomotives that are in use on this line, there is no bogie, but the second pair of driving-wheels are unprovided with flanges, thus easing the engine around the stiff curves which are of such frequent occurrence on the line. The cylinders, it will be seen, are almost horizontal, and the pistons are provided with tail-rods, which work in gun-metal casings bolted to the front cylinder covers. Allan's straight link-motion has been adopted, the valves being balanced. The guides, it will be seen, are of the single-bar type. The boiler barrel is 5 ft. in diameter inside and 11 ft. 6 in. long. The fire-box is also of ample dimensions, being 7 ft. 4½ in. long and 3 ft. 6½ in. wide, inside dimensions. The grate is of the American finger type, the bars being rocked from the foot-plate when necessary for cleaning purposes. It has, it will be seen, a considerable slope, which greatly facilitates the stoking of such a long grate. The crown is stayed direct from the outer fire-box. The working pressure is 165 lbs. per square inch. The brake gear has been supplied by the American Westinghouse Company, and Walker's regulating blast-pipe and the Gresham steam sander have also been applied. The latter must prove very useful on the heavy grades. The lubricating arrangements are, it will be seen, very complete, care having been taken to facilitate the work as much as possible.

The tender is the same as for the passenger engines on the line.

The principal dimensions and particulars of the locomotive are as follows:

Gauge of railway	4 ft. 8½ in.
Diameter of cylinders	18½ in.
Length of stroke	26 in.
Diameter of wheels	4 ft.
Wheel base	15 ft. 6 in.
Mean diameter of boiler	5 ft. 1¼ in.
Length of boiler	11 ft. 6 in.
Length of fire-box casing	8 ft.
Number of tubes	286
Diameter of tubes	1⅞ in.
Heating surface in tubes	1,664 sq. ft.
" " " fire-box	147 sq. ft.
Total heating surface	1,811 sq. ft.
Area of grate	25 sq. ft.

	Tons.	Cwt.
Weight on leading wheels	13	4
" " second leading wheels	14	11
" " driving-wheels	14	13
" " trailing-wheels	13	8
Total	55	16

Tender the same as for passenger engines.

Wheel base of engine and tender	44 ft. 1 in.
Weight of engine and tender in working order	99 tons. 4 cwt.

—*Engineering.*

MEETING OF MECHANICAL ENGINEERS.

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GAS ENGINES.

MR. EMERSON McMILLAN, who was introduced by Secretary Hutton, presided. The subject for the evening was Gas Engines, the discussion of which wso opened by Mr. Reeves. The general purport of his remarks were that gas engines afforded a very convenient means for the subdivision and transmission of power, and that "gas plant would be incomparably more economical than that of compressed air or the electrical or the hydraulic system of transmission of power." The speaker stated further as a "hypothesis," which he hoped to hear discussed, that the near future will see the distribution of energy—all energy—which is derived from coal in the form of a non luminous, cheaply produced fuel gas; that this gas will be relied on entirely for power, for lighting when gas lighting at all is permissible, and when it is not, where the electric lighting is needed, that electric light will be produced through the medium of gas engines, and that this same gas will be used for all sorts of fuel and heating purposes."

Mr. Reeves took a good many more words to say this than we have quoted. He was followed by Mr. Burchard, who read a long and tedious paper of much prolixity which fatigued his audience. In the language of a distinguished physicist, the limit of mental elasticity of his audience was "overpassed" by the strain imposed on it by the paper. While the audience was endeavoring to recover from its permanent set the Secretary read a discussion communicated by Professor William S. Aldrich, of West Virginia University. He spoke of the advantages possessed by gas engines for the distribution of power, their arrangement and the possibility of using "rotary" engines, and the difficulty of regulating the speed of any gas engine, and suggested that tests of such engines were very much needed.

Mr. Richmond was called in and said:

"Mr. Chairman, you are not correct in announcing the fact that we have been making experiments in gas engines. We had need of a motive power for small refrigerating machines in connection with the Delavergne refrigerating machinery, and we started out to find a suitable motor for running those machines, and the first thing that suggested itself was a gas engine, naturally. Well, we thought it would be a good thing to build those gas engines so that we might get all the benefit, and after a little while we were assailed by a number of inventors of gas engines who came to us with propositions something like this: We build the gas engine, and we put about 300 per cent. upon the cost and we divide up on the proceeds between us. (*Laughter*). It seems to me that the gas-engine business is in a rather unhealthy condition in this country at the present moment. Undoubtedly the owners or the licensees of the Otto patents had a very good thing while it lasted, and that rather excited the cupidity of outsiders, and they were prepared, as soon as the Otto patents ran out, to build gas engines at any price they could be sold at and realize an immense fortune for everybody concerned in the matter. I have catalogues, I think, from something like thirty different builders of gas and gasoline engines in this country. It would be hardly fair to quote their prices, but I will tell you that I got as much as 40 per cent. discount quoted at the first slap. I don't know how much I could get by negotiation. (*Laughter*). So it seemed to us that there was very little prospect of dividing up any 200 or 300 per cent. profit. As a matter of fact, the prices are all broken up in the gas engine at the present moment. The subject this evening, of course, has turned on the larger-sized engines used in producer gas, and really my experience is not relevant to that. Nevertheless, as you have called on me, it would be well perhaps to explain my experience. During the summer I was in Europe and looked into this subject of gas engines, and at a very early period I found out that in Europe the gas engine seems to be a back number—I speak of smaller powers, up to 50 H.P.—and in its place they are using oil engines. I was quite taken with the subject. In fact, when I came back I represented to our company that it was quite a good business, and I procured five or six—not gas engines, but oil engines—representing the various different systems of vaporizing oil and using it in an engine, and it is not gas engines that we have been experimenting with. I thought that was quite a revelation. I thought it was very clever to arrive at the conclusion ahead of anybody in America that the oil engine was the coming thing. But when I looked into that again I was not quite so proud of my achievement. It seemed rather extraordinary that American manufacturers were ignorant of the fact that all the makers in Europe were busy with oil engines. I am an Englishman myself, as probably you can guess; and all the familiar names of makers of steam engines, such as Hornsby, Robey, Howard and many others, all have oil engines and are pushing them for all they are worth. So it seemed to me that all we had to do was to get an oil engine. When I came to inquire a little further I found that where gas was too expensive people were using gasoline, and in Europe the gasoline engine had preceded the oil engine, and it was promptly put aside as soon as the oil engine had been developed—by an oil engine I mean an engine using a heavy oil, one flashing at about 100° flash point. These engines will use oil at 100°, 150°, or even 300°. On making further inquiries I found that the oil-engine men had been busy here, and the manufacturers had been busy looking into it and they had not adopted it. So far as I can see the only reason is that where gas is too expensive the people use gasoline. Now, in Europe they cannot use gasoline in the cities because it is absolutely prohibited by the insurance companies. In this country there seems to be some means of conciliating all the different interests. (*Laughter.*) I understand that it is managed something in this way: A man who wants a gasoline engine applies to the authorities, and for a certain consideration he gets a license as a grocer to sell gasoline, and he sells gasoline to himself (*laughter*), and he finds it a very good business, and he runs his gasoline engine. Now, these gasoline engines are sold for what they can get for them—that is to say, that when I take the price-lists in Europe—and they assure me that they can get the price they put on the list with a very slight reduction—I find the gasoline engines are sold at about half the price they are getting in Europe for the oil engines. That first struck me as probably the reason why the American manufacturer is not so ready to take up the oil engine. Nevertheless, I am certainly of the opinion that the oil engine is the engine of the future.

"Now, instead of occupying your time talking about the oil engine, I would like to introduce, Mr. Chairman, a gentleman who came with me—Mr. Wildy, who is a member of the English Institute of Mechanical Engineers and also of the German Society, and who represents Hornsby & Sons, of Grantham, and they claim to have the best oil engine. He has something to say about oil engines, and he can speak with much better authority than I can with the little experience I have had."

The Chairman: We would be glad to introduce Mr. Wildy if he will walk forward where the members may see him.

Mr. W. Lawrence Wildy then stepped to the platform and spoke as follows:

"Mr. Chairman and gentlemen, when I came in here tonight I had no idea that I was going to do anything except listen to the paper of our friend, and I have listened to it with a great deal of interest. I have had a very considerable experience with producer gas, water gas and the ordinary gas in use in engines that is in England, and the figures which he has given to-night I can pretty fully substantiate, only I wish he had gone a little bit further into the question of the actual method of producing the gas in the producer. Most of you know, doubtless, that the producer is an ordinary cylindrical vessel lined with fire-brick and more or less intricate in shape according to the inventor's idea of what his patent is (*laughter*) and with certain cooling surfaces or heating surfaces or conducting surfaces or something; but you will find 150,000 patents in the patent journal doubtless, and they have all got something about them. But the simplest producer I have ever used was a column of fuel about 10 ft. high. The fuel we used in England was coke—the coke which, after the distillation of the gaseous product, was a residue which went to make the cost of the production of gas a mere cipher to the corporation running that gas concern. In Leeds, where I had my experience principally, the gas which was distributed through the houses cost nothing in the holder—it was all profit. (*Laughter.*) I have seen the figures, and I have gone into it with the Chairman of the Gas Committee of the Leeds corporation, and it is a fact that it was a decimal short of nothing in the holder. (*Laughter and applause.*) You laugh, but I am telling you the facts. The by-products from making the bituminous gas were so valuable at that time that they paid all the expense, interest and depreciation of plant, and the gas in the holder cost nothing but distribution and collection of accounts. Metres, of course, are charged by rent there. In proportion to the size of our metre they charge us 18 pence or half a crown or two shillings, so that does enter into consideration, and inside our premises our pipes are all our own, so that the distribution costs from a shilling to 14 pence per day according to the district, and we get good gas, 16 candle-power gas, which, with the Welsbach light, would give us the best part of 50 with a 3-ft. consumption. We get gas supplied for 10 pence per 1000 ft. and 5 per cent. discount for cash in quarterly account. But at the same time we were using enormous quantities of gas for a process which we carried on in our works; that was for the welding of steel tubes. We made tubes of

varying diameter, from 20 in. to 60 in., and these varied in thickness from $\frac{5}{16}$ in. to $\frac{3}{4}$ in., and we welded these with the ordinary coal gas, and our gas bill ran from £6,000 to £7,000 a year, and it came to a pretty heavy item. I got hold of this water-gas process as it was made in Germany at the time, and I saw that it seemed a very good heating medium, very cheaply produced, and we went in for a plant there. The plant was a magnificent success so far as we were concerned. It reduced our gas bill from between £6,000 and £7,000 to just over £1,000 a year—fuel, interest, depreciation, labor, distribution, everything concerned, came over just £1,000 a year, or something under one-sixth of what we paid before. That gas cost us on an average about threepence halfpenny per 1,000 cub. ft. We made only water gas; but we got no by-products, and therefore it cost us nothing in the holder. In the water-gas business there are no by-products. You simply consume your fuel right away there in the blowing-up process or in the cooling-down process, wherein you inject steam and produce carbonic acid first of all at the top, dissociating the water into its constituent parts of carbonic acid and hydrogen. That carbonic acid in going down to a lower temperature parts with its atom of oxygen and absorbs an atom of carbon and becomes carbonic oxide, and that passes to the scrubber, where it is cleaned, and then to the holder. That was the gas with which we reduced our expenses from £6,000 to £1,000 a year. We went further than that by experiment, and after we had made our water gas, which took us for a period of about 10 minutes, we used to blow the generator hot for 10 minutes with a pressure of air of 16 in. or 17 in. water column. We then shut the air off from the bottom, shut the steam in at the top, blew down through that and produced water gas. But that water gas was produced for only a period of four minutes. After that they began to get an amount of carbonic acid in the gas which would have cost too much to remove, and therefore we thought four minutes sufficient. After the four minutes' blow we turned our valves the other way, and we went on producing hydrogen and carbonic acid, and then took the carbonic acid out and got pure hydrogen. We used this in water gas. The ordinary producer gas which we used in our Siemens furnaces for the production of steel plates was produced in a somewhat similar manner, only it was continuous. There we had a cylindrical column of fuel about 4 ft. in diameter and 12 ft. high, and at the bottom of it what we call a trumpet pipe, a pipe that was trumpet-mouthed at the top, and into that came a jet of steam. This jet of steam, at 60 lbs. pressure blowing into the pipe, introduced a strong current of air, so that we got about 8 in. of pressure below the fire, for there were no bars. The fire was simply carried on a brick column of fire-brick, but it left an annulus around this column through which the air could pass by. With that producer we got a gas which gave us 30 per cent. of carbonic oxide and 5, 6, or 7 per cent. of hydrogen and a very small percentage of the olefiant gases which were hardly valuable. After that we went in for other experimental business, and came on to the oil engine which was the subject that Mr. Richmond has kindly fastened on to me to-night. In the oil engine we have a machine which works with the ordinary petroleum of commerce—that is, any of the lighting oils which are in the market. It will also work with the heavier oils up to the specific gravity of .9, and it will work with an oil having a flash point of anything that the ordinary oils have and up to 320° F. Now, an oil of 320° F. is a pretty strong oil. The process through which this oil goes to produce its power is as follows: The engine is provided at the back of the cylinder with a small cylindrical chamber which we call the vaporizer. On to this vaporizer is fixed a valve chamber which really holds two valves and which are the governor valves of the engine; the one opens inward to the vaporizer, the other opens by the action of the governor outward, and through a small pipe conveys any oil which is not required back into the tank from which the pump has drawn it. The rest of the construction of the engine, so far as its communicating the power imparted to it is concerned, is almost identical with the gas engine—a trunk piston and connecting-rod and crank shaft; on the crank shaft a pair of skew wheels, the skew wheels driving a lay shaft—almost identical again with the gas engine—which lay shaft communicates motion, first to the governors and then to two valves, one for the air inlet and the other for the exhaust; the air inlet cam at the same time operates a small pump from $\frac{3}{4}$ in. to $1\frac{1}{4}$ in. in diameter according to the power of the engine to be developed, and this pump has a stroke which can be adjusted by the regulation of the screw—that is, the oil pump—so that the amount of oil which is injected into the vaporizer is exactly in proportion to the power the engine requires. Suppose you are running the engine at half power, you run the pump at half stroke; if you are running the engine at full power, you run the pump at full stroke—that is, if you know you are going to do so. But if you are running the engine at full power and throw off half the machine, the governor will do that; but the effect will not be so perfect as if you, knowing what you want, reduce it yourself. The exhaust valve has a double cam very similar to the gas engine, by which a portion of the compression can be released when starting the engine. Now, in operating the engine you begin by heating the vaporizer with a lamp, an ordinary paraffine lamp with a circular wick to which a small fan is attached, producing for the time being a little petroleum forge. It takes 5 to 10 minutes to heat that vaporizer. The only process is to fill the lamp and turn the fan-handle. As soon as it is hot enough it is knocked by a cock on the cylinder, and you can turn your fly-wheel and your engine goes off at full cock; it is ready immediately, and it goes off at full power then and there, governing itself as the governors dictate. The governing is brought about by the distention of the governor balls acting on a lever which depresses the second valve that I spoke about in the little valve chamber on the vaporizer, so that the oil which is pumped up and which is in constant supply is rejected from the vaporizer—never allowed to enter it, because the first valve has a slight spring on it of an ounce to the square inch, and if the upper valve is open you can readily realize that as there is an escape to the oil it will not even open with that an ounce to the square inch, so that the power lost is enough to pump a good deal less than half a thimbleful of oil and return it to the vaporizer. Immediately on starting the lamp goes out. By that I mean that we have got to such a gauge that the lamps, if properly filled, will run just long enough to heat the vaporizer to the right temperature, and will be burned out at that time. In England, when our experts go out to teach anybody there to start engines, they say to the men, 'You just work that handle gently until that lamp goes out.' We have no lamp, we have no tube, we have no electricity, but the continual combustion of the oil in the vaporizer restores to the vaporizer the heat which has been extracted by the vaporization of the oil and the heating of the air necessary to produce the subsequent explosion. These engines have been running continuously for two months, day and night, without stopping, without any hitch whatever, and the higher the work that is taken out of the engine up to full power, the better the engine works. At very low powers the engine will want a little nursing perhaps, but at full power she will work right along. We start our engine at 5.30 in the morning, and the men come in at six o'clock, and she is never looked at again except when the man goes in at dinner-time and oils her, and at half-past five when he goes to stop her, and there is no outside flame, no exposed red heat or dangerous flame of any sort about the engine.

A Member: What do you mean by nursing?

Mr. Wildy: I mean this: that if the engine has to run light for five or six hours—which I suppose no sane man would do under ordinary circumstances—it is possible that he may want to put a little brake on to the engine, or something of that sort—to put a little work on her.

Mr. Holloway: Is there any residuum in the cylinder?

Mr. Wildy: None whatever. We have run her for two months, and there is not as much as you could wipe off with your hand.

Mr. Oberlin Smith: What was the efficiency of the various sizes in fuel per H.P. hour, rating the oil at the same price as coal?

Mr. Wildy: I can hardly give you that here. The consumption runs about $\frac{3}{4}$ of a pint of American Daylight or Water White per H.P. on all sizes of engines. It runs a little lower, but only a little lower, on the larger engines than on the smaller ones. The very small ones will run to a pint. There is a greater loss owing to the friction of the engine itself. I am giving you per brake H.P. in that case, not I.H.P. We sell the engine on the power which the purchaser is going to get off the fly wheel. He doesn't care what the power is in the cylinder. He wants what he will get off the fly-wheel. A 16-H.P. engine uses just .8 of a pint.

The Chairman: Mr. Burchard, yours uses about a pound of carbon?

Mr. Burchard: Yes, sir, about a pound of carbon in the gas.

The Chairman: A pint weighs about a pound. Your $\frac{3}{4}$ Imperial would weigh about a pound?

Mr. Wildy: Yes, that is so, sir. In Russia they are adopting these engines, and we cannot keep pace with them. With us in England it is a matter of consideration, because the oil, which, I understand, you give about 7 cents a gallon for, costs us about sixpence halfpenny a gallon. They are doing wonderfully well with the engines over there. Every class of power user is adopting them to the rejection of all steam engines up to 50 or 60 H.P. They are in the hands of stablemen, gardeners, coachmen, all sorts of people who, after they are once instructed, know what to do.

Mr. Perry: How about the noise from the explosion? Is it less than from the gas engine?

Mr. Wildy: The pressures in the oil engine are rather lower. In the Scotch gas I have had as much as 210 lbs. initial pressure in the gas engine. The consequence is that the terminal pressure is so high that the exhaust end becomes noisy. What is your engine pressure? (*To Mr. Burchard.*)

Mr. Burchard: About 180 lbs.

Mr. Oberlin Smith: About what is the price of this engine compared with engines of like power, after the 40 per cent. is taken off?

Mr. Wildy: I am afraid you have got on the wrong track. Mr. Richmond was not alluding to our engine. We do not do business that way in this country.

Mr. Oberlin Smith: We want to get the 300 per cent.

Mr. Wildy: Three hundred per cent.—that is nearer the mark. I am much obliged to you, gentlemen.

Dr. Emery: I think we are all grateful to the gentleman for his very complete description of the apparatus. But I would like to ask a question which has occurred to me. I cannot see how you can pump the air into a hot chamber and let part of it run out without some danger of explosion. I suppose that the stroke of the pump is timed so as to put that into the chamber at the proper time.

Mr. Wildy: That is a matter that I evidently missed. The fact is, that the oil is injected into the cylinder on the outward stroke of the piston while it is drawing air in, and if the governor at that moment says, "You shall not have any more oil," it rejects the remainder of the oil, the back pressure closes, and the rest of the oil goes back into the tank. The oil which has gone into the vaporizer has gone in at a period of suction. I dare say if we could get a very light scale in the indicator we could show very low vacuum there.

Dr. Emery: Where does it go—the oil? Does it go first into the cylinder or into the hot chamber?

Mr. Wildy: Into the hot chamber. It never goes into the cylinder. The explosion only goes into the cylinder. The hot chamber is a little Stilton cheese joined on to the main cylinder by a small rectangular neck, so that only a very small proportion of the vapor oil ever gets into the cylinder until the compression stroke comes on, and at that point, owing to the compression and the temperature of the vaporizer, the explosion takes place and the impulse is given to the engine, and it is by that particular arrangement of adjusting to each engine the exact capacity, the vaporizer and the temperature of the vaporizer, that we get our explosion just at the right moment. Unfortunately I have not any diagram with me.

Mr. Jesse Smith: What maintains the temperature of the generator?

Mr. Wildy: The continual combustion of the oil.

Mr. Smith: Whereabouts?

Mr. Wildy: In the vaporizer. There is no generator. It is nothing but a vaporizer.

Mr. Smith: There is a fire inside?

Mr. Wildy: No, sir, there is no fire inside. It is such a black heat that it would only just melt tin.

Mr. Smith: What maintains that temperature?

Mr. Wildy: The combustion of the oil.

Mr. Smith: But the combustion takes place in the cylinder of the engine.

Mr. Wildy: No, sir; it takes place in this vaporizer and communicates by this little narrow neck.

In answer to a question by the Chairman, Mr. Wildy said further:

"With gas at two shillings per 1,000 ft. we run rather cheaper with the oil even at sixpence halfpenny. The gas-engine makers will tell you that they use 14, 16, 18 cub. ft. to the H.P. As a matter of fact, they will use 25 to 30 cub. ft. in regular work. But with the producer gas you will use at the very least 90 to 100 cub. ft. of gas, and then you have always to provide an attendant to the producer and the steam boiler, and you have got a great deal more plant to put down for that gas engine than the oil engine. When you come to take into consideration the depreciation on the first cost and labor, you get a cheaper engine with the oil engine than with the producing gas engine."

A Member: What causes the explosion in the vaporizer?

Mr. Wildy: The temperature of the vaporizer and the compression of the mixture. There is no electric spark, no flame, no ignition tube. There is nothing after you have once started the engine but the temperature of the vaporizer. If there is any gentleman who doubts at all what I am saying to-night, if he will visit the Delavergne Company's works, where they have got one of these engines, Mr. Richmond will be only too pleased to let him see that engine running, and show him that there is nothing whatever but the temperature of the vaporizer and the compression to produce that. To prove to you that it is the compression, we use a different amount of compression for American oil from what we use for Russian oil, and the engines are all adapted, so that you can make an engine here to-day and use it on Daylight oil, and send it to Russia to-morrow, and by altering it in a little matter which will take perhaps seven minutes you can use it with Russian oil. The Russian oil requires 25 to 30 per cent. more compression than the American oil.

The Chairman: Have you determined the temperature of the ignition there with the power you are running at?

Mr. Wildy: It does not matter what the temperature is provided it is not below 400°. We find that at 400°—the melting point of tin—we could start any engine with any oil.

Mr. Holloway: As we understand it, the oil lies in the vaporizer until the compression raises the temperature.

Mr. Wildy: No, sir. The instant it is in the vaporizer it is vapor because our vaporizer is at black red heat. The compression will increase the temperature a little, of course, but it will not be a very great matter. We put a block of tin on there; the moment that melts that is the proper point to start the engine.

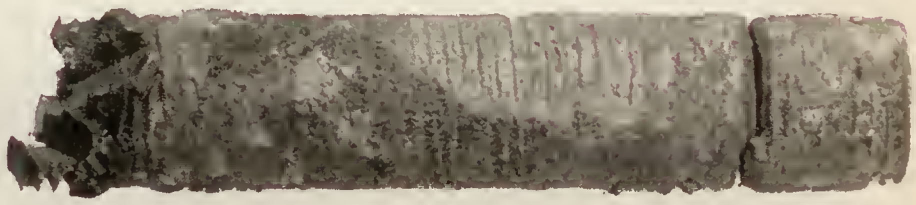
Then followed a desultory discussion of no special value, with which the evening closed.

The next meeting will be held on the evening of May 8, when Mr. F. W. Dean will read a paper on the Efficiency of the Compound Locomotive.

NOTES AND NEWS.

Electric Light Unreliable.—The Midland Railway of England has been forced to abandon the electric lighting system, with which several of its trains have been equipped, on account of its unreliability and expensiveness. The trains will hereafter be illuminated by Pintsch gas. The electric system furnished a beautiful light; but unfortunately the efforts of the mechanical department of the road to perfect it sufficiently to meet the requirements of the service were unavailing.

Stay-bolt Broken at Two Places.—The engravings, figs. 1, 2 and 3, represent a stay-bolt sent to us by Mr. David Holtz, of the Western Maryland Railroad, which, as shown, when taken out of the boiler was broken at both *A* and *B*. Fig. 2 is an end view of the fracture at *A*, and fig. 3 a similar view at *B*. The bolt was screwed into the plate and was broken at *B*, the portion remaining in the plate not being shown.



A B

Fig. 1.

Fig. 2. Fig. 3.

STAY-BOLT BROKEN IN TWO PLACES.

This break was an old one, and complete. The fracture at *A*, however, was not entirely complete when it was taken out of the boiler, a small area of bright, freshly broken metal being shown just above the centre in fig. 2. It is difficult to assign any satisfactory cause for these two breakages. Have any of our readers observed similar instances?

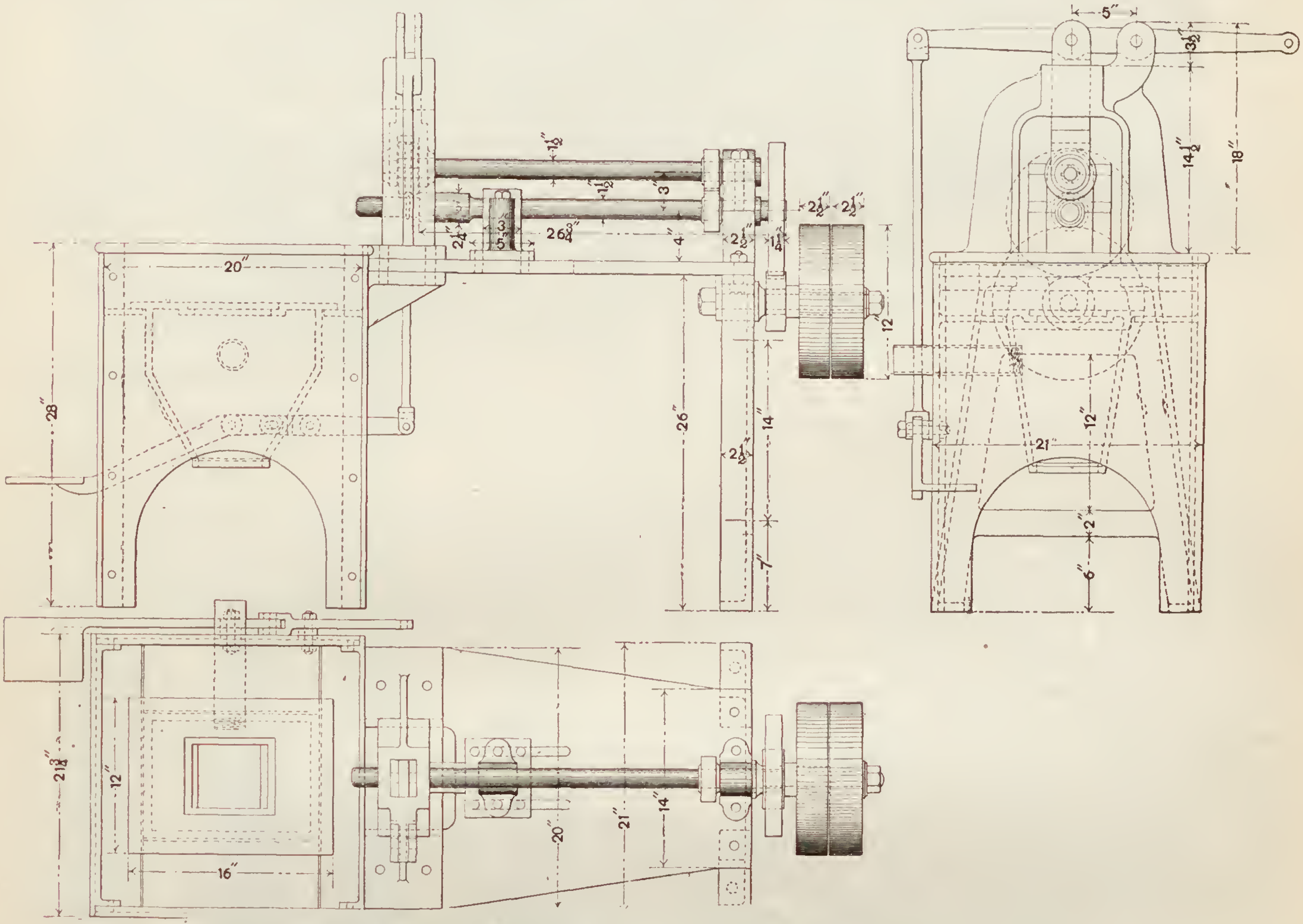
Aerial Tramway over Niagara.—A bill, it is reported, has been sent to Albany, and will be introduced into the Legislature, authorizing a company to erect a tower and landing place in the State Reservation Park for a scheme which all right-minded people ought to condemn. The company proposes to carry tourists across the Niagara River over the brink of the cataract and 30 ft. above the raging waters. A double set of cables will be stretched from the towers in the Canadian and American parks, with a supporting tower on Goat Island. On these cables cage-like cars will be suspended by trolleys and operated by electricity from the American side. The aerial line will follow along the brink of the American Falls to Goat Island, and thence to the Canadian shore, form-

ing a cord to the bow of the Horse Shoe Falls. The floors of the cars will be perforated to allow visitors to look below, and the side views will also be unobstructed. It gives one a desire to perforate the bodies of the projectors of this scheme merely to read about it. Are there to be no places on earth exempt from the invasion of the trolley?

Rack-rail Roads.—According to *The Engineer* there are up to the present time 19 railways using the Abt system, with a total length of 207.55 miles, of which 105.77 miles are supplied with rack-rail. Fourteen of these railways are in Europe, two in South America, one in Japan, one in the West Indies, and one in Manitou & Pike's Peak Railway, in the United States. The *Indian Engineer* says that in addition to this 26 railways using the "Ladder" or Marsh rack have been built. These have a total length of 100.59 miles, partly rack and partly adhesion, of which 21 are in Europe, two in Brazil, one in Sumatra, and two in the United States—viz., the Mt. Washington Railway and the Mt. Desert Railway.

that the masters' association shall cause to be paid to the men such arrears of pay as have been withheld from them, under the agreement, whether with the consent of the men or otherwise; that Mr. Rees was at liberty to employ or discharge such men as he deemed fit, and that he therefore be not called upon to reinstate all or any of them, but that the men displaced should not be put to any disadvantage in obtaining employment. It is also recommended that in future differences the negotiations should be confined to the authorized officials of the two societies.

Tube-Beading Machine, Philadelphia & Reading Railroad.—Among the special tools that have been built at the shops of the Philadelphia & Reading Railroad, at Reading, Pa., for use at that point, is the tube-beading machine illustrated in the accompanying engraving. The tubes are beaded down at the fire-box end to take a copper ferrule, and expanded a trifle at the smoke-box end to avoid too much rolling out. Formerly the beading was done so as to form a shoulder, but



TUBE-BEADING MACHINE, READING SHOPS, PHILADELPHIA & READING RAILROAD.

this practice has been abandoned. The engraving illustrates both the forge in which the tubes are heated and the beading machine. The latter stands directly back of the fire, and is driven by a 2-in. belt running on the pulleys shown at the rear. By following the lever action from the treadle at the front of the forge to the application of the pressure on the tube it will be found that a very heavy downward pressure is brought to bear upon the tube, which is slipped over the lower mandril, by the roller on the upper shaft. When the tube has been heated the workman simply slips it over the lower mandril, bears down on the treadle, and in a few turns the beading is finished. A similar machine is used at another forge for welding the ends on to tubes.

Practicable Arbitration.—The following account of the way in which a dispute between men and their employers was settled in Liverpool will indicate the beneficent results of arbitration when each side is disposed to deal fairly with the other, and when each is represented by intelligent and just arbitrators:

For some days in January a carters' strike had been imminent in Liverpool, as a consequence of a dispute between the Liverpool Cartowners' Association (Limited) and the Mersey Quay and Railway Carters' Union. It was feared that the trade of the port would be greatly hampered, the union carters numbering about 3,000. The dispute arose out of an alleged breach by Mr. Joseph Rees, an employer, of an agreement entered into in 1892 between the two organizations in regard to payment for overtime. The men gave a week's notice, to terminate on Saturday last. In the mean time, as a result of negotiations, it was agreed to refer the points at issue to arbitration. Messrs. George H. Cox (Vice-Chairman of the Liverpool Board of Conciliation) and William Chadwick were the arbitrators selected, and the Lord Mayor of Liverpool acted as umpire. The finding of this tribunal was announced by the Lord Mayor at the Town Hall on Saturday to the secretaries of the disputing organizations. The award is to the effect that the agreement has not been strictly adhered to;

The New Torpedo-Boats.—The Naval Construction Board, consisting of Chief Constructor Hichborn, Engineer-in-Chief Melville, and Commodores Sampson and Chadwick, which has under consideration the various bids opened February 19 for three sea-going torpedo-boats, has made five alternate recommendations to Secretary Herbert, as follows:

First—All three boats might be awarded to the Columbian Iron Works, Baltimore, at their bid of $97,500 each for the three boats.

Second—Two to the same company at their bid of $103,000

each, and the other to the Union Iron Works, San Francisco, at $135,000.

Third—Two to the Columbian Iron Works at $103,000 each

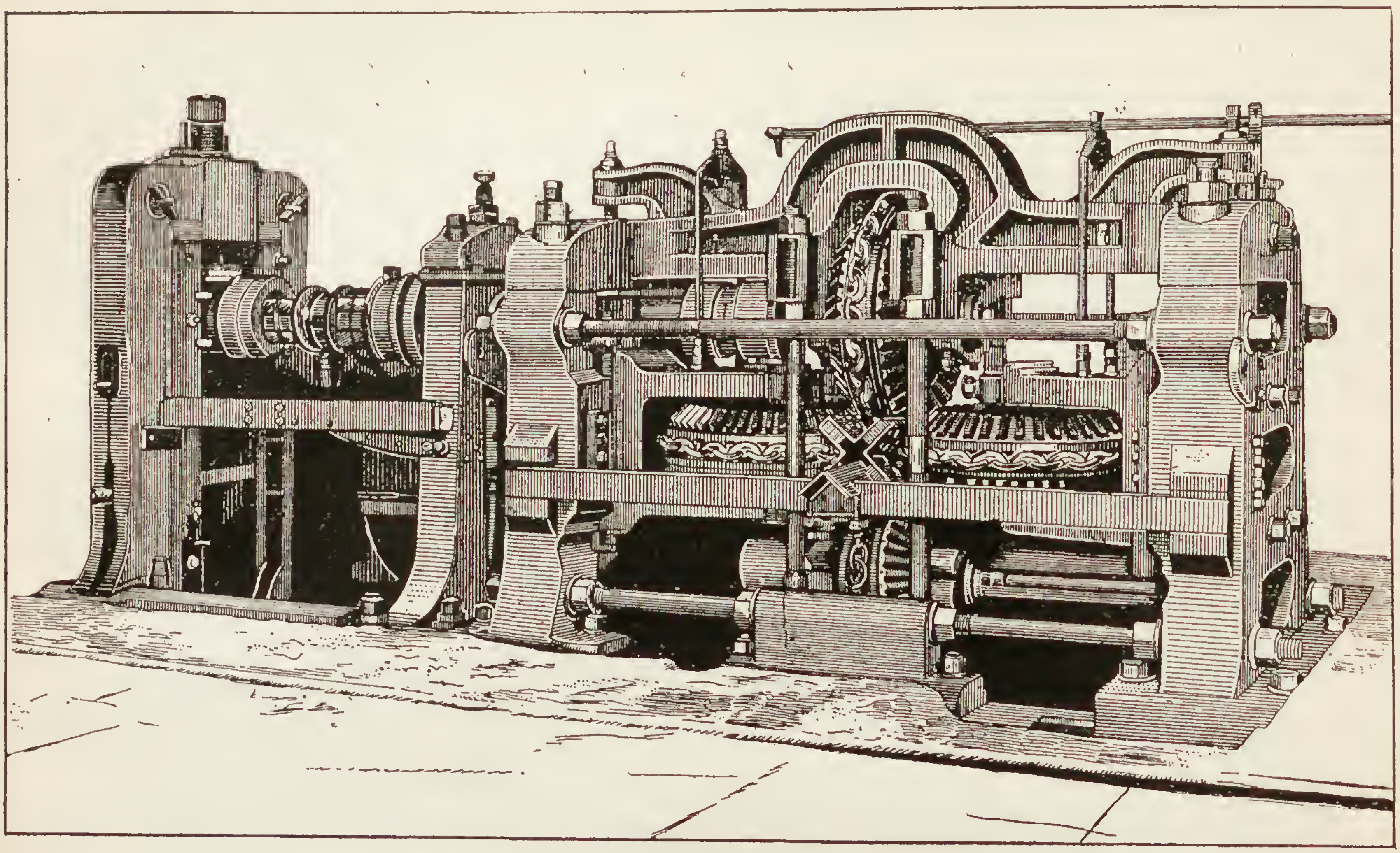


Fig. 1.

MACHINE FOR ROLLING CHAINS.

and one to the Herreshoffs of Newport at $113,850, the latter boat guaranteed to have a speed of 25 knots, all the others having but 24½, according to the original specifications.

Fourth—One to the Columbian Iron Works at $107,000, one to the Union Iron Works at $135,000, and one to Hugh Ramsey, of Perth Amboy, N. J., at $126,000.

Fifth—Two to the Columbian Iron Works at $103,000 each, and to accept the proposal of the Union Iron Works to build a 240-ton boat with a guaranteed speed of 28 knots for $243,000.

The latter vessel would be 100 tons larger than the others, and her completion, including equipment, could not be accomplished without exceeding the appropriation allowed for the three vessels, the amount available for their construction and equipment being only $450,000.

The Construction Board decided that none of the special designs submitted to the department, some of which involved bronze hulls and aluminum bracing, were worthy of consideration, and determined that the departmental specifications for all steel vessels should prevail. The supplemental bid filed last Saturday from the Herreshoffs, guaranteeing a 25-knot boat, will probably be among those accepted.

Machine-Rolled Chains.—Mr. J. C. Monaghan, the United States Consul at Chemnitz, has sent in a report to the State Department regarding the machine for rolling chains. We reproduce the engravings accompanying the report, and the report itself in full:

"A recent invention of rolls for making chains seems destined to revolutionize the whole trade of iron and steel-chain making. It does away with the welded joint and secures uniformity, rapidity, and increased strength in construction. It was brought to my attention during an investigation of tin rolling. The new machine resembles somewhat the machine or roll that sinks impressions in hot or steamed wood—*i.e.*, its mode of working is similar. There is, first of all, the roll (fig. 1), and, second, a peculiarly formed bar of iron (fig. 2). The rolls are four in number, and are so situated and so arranged that they work simultaneously on the curiously formed iron bar, cutting it into links. A glance at fig. 1 will reveal much more of the *modus operandi* than any description in words would do. The curves that look like chain links are the highly tempered—*i.e.*, hardened, steel dies or cutters. The gears fit into each other and operate simultaneously on the four flanges of the iron bar. At a point just back of the cross—that is, in front of the gears of fig. 1—the projecting cutters of the gears almost meet. Through this point passes the iron or steel bar at white heat. The gears revolve rapidly, turning out 3 to 4 yds. of chain per second. The iron bar that goes in looking like fig. 2 comes out looking like fig. 3. By means of tongs, and cutters, and moulds fig. 3 is made to look like fig. 4, in which the links are held together by very thin bits of iron which are easily cut. After some little labor in cleaning the links, the chain is run into a furnace, heated red, and then run through rolls to give its links the shape seen in fig. 5. It is claimed that this machine-made chain is better than the hand welded; that it does not require wrought or welding iron, but that it gives better results with fused irons and steels."

Fig. 2. Fig. 3. Fig. 4. Fig. 5.

VARIOUS STAGES OF MACHINE-ROLLED CHAINS.

THE DETERIORATION OF LOCOMOTIVE AND MARINE BOILERS DUE TO EXPANSION, AND THE MEANS OF LESSENING THE SAME.*

By Herr Lentz.

(*Concluded from page 168.*)

In some quarters the further introduction of the stayless boiler is regarded as dangerous, or it is advocated that the corrugated furnaces should be connected to the outer shell with stay-bolts, so that a further comparison might be made later, since we are not perfectly clear as to the cause of the deformation just mentioned.

Now, a few months before the accident, while a new furnace was being put in a boiler at Nippes, I was inspecting it and found that the corrugated portion had contracted so that the furnace was about 1.2 in. shorter on the top and .4 in. shorter on the bottom than it should have been; a fact that neither the maker of the furnace nor myself could explain, unless we attributed it to imperfect workmanship.

According to the Schulz-Knaudt investigations, we have the following rules for the compressibility and limit of elasticity of corrugated flues:

1. The unit of compressibility for corrugations 2 in. deep is .0041 in. per foot of length, for sheets .39 in. thick, and subjected to a pressure of 20,000 lbs. per square inch, the furnace having a diameter of 37.5 and 41.5 in.
2. The amount of compressibility varies approximately with the mean diameter of the flue, the thickness of metal remaining the same.
3. The amount of compressibility varies approximately as the square of the thickness of the metal, the diameter of the flue remaining the same.
4. The amount of the limit of elasticity per foot of length is 10 times as great for a thickness of metal of .39 in. as the unit given in 1.
5. The amount of the limit of elasticity per foot of length is independent of the diameter of the flue.
6. The amount of the limit of elasticity is approximately proportional to the thickness of the metal.
7. In corrugated flues having different depths of corrugation, the amount of compressibility with the same thicknesses of metal and the same outside diameters is proportional to the square of the average depth of the corrugations.
8. In corrugated flues with different depths of corrugations the amount of the limit of elasticity is proportional to the average depth of the corrugations.
9. Accordingly, by a comparison of three corrugated flues, wherein the outside diameter is $41\frac{1}{3}$ in. and the metal .40 in. thick, with corrugations $1\frac{3}{16}$ in., 2 in., and 3 in. deep, we find the following state of affairs to exist:

Depth of Corrugations.	Average Depth of Corrugations.	Ratios of the Average Depth of Corrugations.	Square of this Ratio.	Compressibility per ft. of Length at 20,000 lbs. Pressure.	Limit of Elasticity per ft.
1.2 in.	.80	1	1	.0010 in.	.0225
2.0 "	1.60	2	4	.0040 "	.0450
3.0 "	2.60	3.25	10.56	.0108 "	.0732

TABLE A.—ELASTICITY AND LIMIT OF ELASTICITY OF FLUES WITH CORRUGATIONS 50 M.M. (2 IN.) DEEP.

Thickness of metal		.39	.41	.43	.45	.47	.49	.51	.53	.55	.57	.59	.61	.63
Square of metal thickness		.1521	.1681	.1849	.2025	.2209	.2401	.2601	.2809	.3025	.3249	.3481	.3721	.3969
Limit of elasticity		.045	.043	.041	.039	.0375	.036	.0346	.0334	.032	.0311	.030	.029	.0281
Diameters of Flues.	Mean Diameter.													
29.5-33.5	31.5	.0052	.0047	.0043	.0039	.0036	.0033	.0031	.0028	.0026	.0025	.0023	.0022	.0020
31.5-35.5	33.5	.0049	.0044	.0040	.0037	.0034	.0031	.0029	.0027	.0025	.0023	.0022	.0020	.0019
33.5-37.5	35.5	.0046	.0042	.0038	.0035	.0032	.0029	.0027	.0025	.0023	.0022	.0020	.0019	.0018
35.5-39.5	37.5	.0043	.0039	.0036	.0033	.0030	.0028	.0026	.0024	.0022	.0021	.0019	.0018	.0017
37.5-41.5	39.5	.0041	.0037	.0034	.0031	.0029	.0026	.0024	.0023	.0021	.0020	.0018	.0017	.0016
39.5-43.5	41.5	.0039	.0036	.0032	.0030	.0027	.0025	.0023	.0021	.0020	.0019	.0017	.0016	.0015
41.0-45.0	43.0	.0038	.0034	.0031	.0028	.0026	.0024	.0022	.0021	.0019	.0018	.0017	.0016	.0015
43.0-47.0	45.0	.0036	.0032	.0030	.0027	.0025	.0023	.0021	.0020	.0018	.0017	.0016	.0015	.0014
45.0-49.0	47.0	.0034	.6031	.0028	.0026	.0024	.0022	.0020	.0019	.0018	.0016	.0015	.0014	.0013
47.0-51.0	49.0	.0033	.0030	.0027	.0025	.0023	.0021	.0019	.0018	.0017	.0016	.0015	.0014	.0013
49.0-53.0	51.0	.0032	.0029	.0026	.0024	.0022	.0020	.0019	.0017	.0016	.0015	.0014	.0013	.0012
51.0-55.0	53.0	.0031	.0028	.0025	.0023	.0021	.0020	.0018	.0017	.0016	.0015	.0014	.0013	.0012
53.0-57.0	55.0	.0029	.0027	.0024	.0022	.0020	.0019	.0017	.0016	.0015	.0014	.0013	.0012	.0012
55.0-59.0	57.0	.0028	.0026	.0024	.0021	.0020	.0018	.0017	.0016	.0015	.0014	.0013	.0012	.0011

TABLE B.—ELASTICITY AND LIMIT OF ELASTICITY OF FLUES WITH CORRUGATIONS 75 M.M. (3 IN.) DEEP.

Thickness of metal		.39	.41	.43	.45	.47	.49	.51	.53	.55	.57	.59	.61	.63
Square of metal thickness		.1521	.1681	.1849	.2025	.2209	.2401	.2601	.2809	.3025	.3249	.3481	.3721	.3969
Limit of elasticity		.0732	.0697	.0665	.0624	.0610	.0586	.0516	.0542	.0523	.0505	.0488	.0472	.0457
Diameters of Flues.	Mean Diameter.													
27.5-33.5	30.5	.0137	.0124	.0113	.0104	.0095	.0087	.0081	.0075	.0070	.0065	.0060	.0057	.0053
29.5-35.5	32.5	.0129	.0117	.0107	.0097	.0089	.0082	.0076	.0070	.0066	.0060	.0057	.0053	.0051
31.5-37.5	34.5	.0122	.0110	.0101	.0092	.0085	.0078	.0072	.0066	.0063	.0057	.0054	.0051	.0048
33.5-39.5	37.5	.0115	.0105	.0095	.0088	.0080	.0074	.0067	.0063	.0058	.0054	.0052	.0048	.0045
35.5-41.5	38.5	.0109	.0098	.0090	.0083	.0076	.0070	.0064	.0060	.0056	.0052	.0048	.0045	.0043
37.5-43.5	40.5	.0103	.0094	.0085	.0078	.0072	.0066	.0061	.0057	.0053	.0049	.0046	.0043	.0040
39.5-45.5	42.5	.0099	.0089	.0082	.0075	.0069	.0063	.0059	.0054	.0051	.0047	.0044	.0041	.0039
41 0-47.0	44.0	.0095	.0086	.0078	.0072	.0066	.0061	.0056	.0052	.0048	.0045	.0042	.0039	.0037
43.0-49 0	46.0	.0090	.0081	.0075	.0068	.0063	.0058	.0053	.0050	.0046	.0043	.0040	.0037	.0035
45.0-51.0	48.0	.0086	.0078	.0072	.0065	.0060	.0055	.0051	.0047	.0044	.0041	.0038	.0036	.0034
47.0-53.0	50.0	.0083	.0076	.0069	.0063	.0058	.0053	.0049	.0045	.0042	.0040	.0037	.0035	.0032
49.0-55.0	52.0	.0080	.0073	.0066	.0061	.0056	.0051	.0048	.0044	.0041	.0038	.0035	.0033	.0031
51.0-57.0	54.0	.0078	.0071	.0064	.0059	.0054	.0050	.0046	.0043	.0040	.0037	.0034	.0032	.0030
53.0-59.0	55.0	.0075	.0067	.0062	.0056	.0051	.0045	.6044	.0041	.0038	.0035	.0033	.0031	.0029

According to calculations which I will present to you, it is probable that the furnace was upset to the amount of these measurements, and must likewise, in accordance with other measurements, have experienced a flattening of about 4 in., though the diametrical measurements have unfortunately not been verified.

The engine was in heavy express service for three weeks in this condition, and this was enough to increase the flattening (to about 8 in.), so that it collapsed under the pressure of the steam.

In calculating on the efficiency of this boiler, I have come to the conclusion that it evaporated about 13,200 lbs. (1,500 galls.) of water per hour into steam of 180 lbs. pressure.

From the known investigations on elasticity I have calculated Table A for a depth of corrugation of 50 mm. (2 in.), and Table B for a depth of corrugation of 75 mm. (3 in.). The latter can make no claim to absolute accuracy, since furnaces with that depth of corrugation are not in demand, and I can only check them off with the results obtained with corrugations having a depth of 30 mm. ($1\frac{3}{16}$ in.) and 50 mm. (2 in.); but it is approximately correct.

* Paper read before the *Verein für Eisenbahnkunde*.

In these tables the thickness of the metal is given in the top line; in the second there is the square of the thickness of the metal; and in the third the limit of elasticity, which means the fraction of an inch which a corrugated flue 1 ft. in length must be compressed in order to reach its limit of clasticity. This is the same for different diameters of flues, but varies greatly with the increasing thickness of metal. In the columns beneath these there is given the compression which the various sizes of corrugated flues would experience per foot of length under a load of 20,000 lbs.

From this it will readily be seen how the corrugated flue stiffens as the thickness of the metal is increased, and how the elasticity is increased by making the corrugations 3 in. deep. Its limit of clasticity is about twice, and its actual elasticity is fully three times as great as in the case of flues with corrugations 2 in. high. An accurate calculation shows that the corrugated flue on the express engine of the Left-Bank-of-the-Rhine Railway was compressed about .37 in. at the top and about .23 in. at the bottom in the direction of its length, whereby the limit of elasticity was exceeded by about .20 in. at the top and about .06 in. at the bottom, as is fully set forth and explained in the following Table C.

TABLE C.

Equalized Comparison of Corrugated Flue Boilers in Working Order.

No.	Description of Parts of Locomotive.	State Railways. Left Bank-of-the-Rhine. Express Locomotive. With Ordinary Corrugated Flues.	Left Bank-of-the-Rhine. With Elastic Tube Sheets.	Left Bank-of-the-Rhine. With Deep Corrugations.	Hanover. With Copper Fire-box.
1	Depth of corrugations......in.	2	2	3	....
2	Steam pressure..lbs. per sq. in.	210	210	210	180
3	Outside diameter of flues....in	47.4	45.3	45.3	....
4	Thickness of metal..........in.	.60	.55	.47	....
5	Fibre stress.....lbs. per sq in.	7,950	7,050	9,500	....
6	Unit of fibre stress, lbs. per sq. in.	6,800	6,970	6,800	....
7	Number of corrugations........	19	14	21	....
8	Length of corrugated portion, in	113.00	83.23	124.80	....
9	Mean length of flue or fire-box, in.	132.00	116.15	126.00	84.37
10	Length of tubes.............in.	118 11	143.70	124.00	153.55
11	Number of tubes............	241	194	241	219
12	Inside and outside diameter of tubes..........in.	1.65—1.46	2—1.77	1.81—1.61	1 81—1.61
13	Sectional area of tube metal, sq. in	140.82	102.18	129.15	....
14	Heating surface of fire-box, sq. ft.	118.4	98.0	133.5	96.9
15	Heating surface of fire-box in per cent. of total H. P	11.9	8.2	11.27	7.5
16	Heating surface of tubes, sq. ft	874.6	1077.5	1051.1	1184 0
17	" " total .. sq. ft.	993.0	1175.5	1184.6	1280.9
18	Grate area..............sq. ft.	21.5	19 4	19.4	24.8
19	Length of grate, including fire-brick ....in.	88.6	60.4	86.6	88.6
20	Length of combustion chamber, in.	43.3	36.2	39.4	....
21	Maximum coal consumption per hour per sq. ft. of grate area, lbs.	109.6	109.6	121.9	....
22	Maximum coal consumption per hour for the whole grate, lbs.	1,650	1,650	1,650	2,046
23	Maximum evaporation, lbs.....	13,200	13,200	13,200	15,400
24	" " fire-box, per cent. of whole..........	41	34	40	32
25	Maximum evaporation, tubes, per cent. of whole........	59	66	60	68
26	Maximum evaporation, fire-box, lbs.	5,412	4,488	5,280	5,082
27	Maximum evaporation, tubes, lbs.	7,788	8,712	7,920	10,318
28	Maximum evaporation, fire-box, per sq. ft............lbs.	45.5	45.5	39.4	52.3
29	Maximum evaporation, tubes, per sq. ft...........lbs.	8 8	8.2	7.7	8.5
30	Temperature of steam, Fahr....	387	387	387	374
31	Mean temperature of fire-box, Fahr	752	752	698	793
32	Mean temperature of tubes, Fahr	537	536	534	523
33	Mean temperature of outer shell Fahr..	369	369	369	357
34	Average difference of temperature between corrugated flue and shell..............Fahr.	383	383	328	436
35	Average difference in temperature between tubes and shell Fahr	168	167	165	166
36	Relative expansion of fire-box, in.	.33	.29	.27	.24
37	Relative expansion of tubes, in.	.13	.16	.13	.17
38	" " below grates, in	.03	.02	.03	....
39	Relative expansion of stay-bolts in.	....	....	....	.003
40	Relative expansion below combustion chamber	.11	.09	.08	....
41	Total relative expansion of corrugated flue and tubes at the top..........	.46	.45	.40	.41
42	Total relative expansion of corrugated flue and tubes at the bottom.........	.27	.28	.24	.52
43	Smallest diameter of boiler, in.	65	65	65	55
44	Thickness of metal .... in.	67	.67	.67	.55
45	Sectional area of metal..sq. in.	136.6	136.6	136.6	95.4
46	Longitudinal strain on boiler from steam pressure . lbs.	658,577	658,577	658,577	406,395
47	Longitudinal strain per sq. in. of metal..............lbs.	4,821	4,821	4,821	4,260
48	Extension of boiler resulting from longitudinal strain...in	.043	.043	.043	.036
49	Excess of compression of fire-box at top.............in.	.417	.407	.357	.374
50	Excess of compression of fire-box at bottom........ in.	.227	.237	.197	....
51	Compression of corrugated flues per ft. of length at 20,000 lbs., in.	.0019	.0023	.0075	....
52	Total compression of the whole flue....................in.	.0163	.0159	.0780	....
53	Expansive pressure of the corrugated flues upon the tubes, lbs.	511,656	511,949	91,538	....
54	Steam pressure upon the tube-sheet, deducting the tube areas .... lbs.	240,548	202,694	196,720	....
55	Resultant pressure on tubes, lbs	271,108	309,255	....	....
56	" " " " per sq. in. of metal ......lbs.	1,925	3,026	....	....
57	Resultant pull on tubes....lbs.	....	....	105,182	....
58	" " " " per sq. in. of metal ....lbs.	....	....	815	....
59	Resultant shortening of tubes, in.	.008	.015	....	....
60	Resultant lengthening of tubes, in	....	....	.0095	....
61	Excess of compression of fire-box at top.............	.409	.392	.3600	....
62	Excess of compression of fire-box at bottom...........	.227	.237	.197	....
63	Limit of elasticity of corrugated flues per ft. of length..... in.	.030	.032	.061	....
64	Limit of elasticity of the whole flue.....................in.	.2825	.2219	.6344	....
65	Limit of elasticity reduced to $\frac{14}{23}$ in.	.1719	.1350	.3605	....
66	Limit of elasticity exceeded at the top ....in.	.2371	.157	....	....
67	Limit of elasticity exceeded at the bottom..............in.	.0551	.1020	....	....
68	Compression falling short of limit of elasticity at the top, in.	....	....	.0005	....
69	Compression falling short of limit of elasticity at the bottom...................in.	....	....	.1635	....
70	Minimum necessary expansion for flexible sheet.........in.	.20	.24	....	.40
71	Maximum necessary expansion for flexible sheet..........in.	.37	.38	....	.60

No. 6 shows the actual demands that are made upon the metal.

Nos. 7 and 8 are given as they determine the elasticity and limit of elasticity.

No. 15 serves for the calculation of Nos. 24 and 25.

Nos. 21 and 23 and 26 and 27 give the maximum coal consumption and the steam production that obtains in actual service.

Nos. 24 and 25 are calculated on the authority of Couche.

No. 31. The mean temperature of the corrugated flues is taken from Hirsch's experiments, and, indeed, in order to determine the temperature of sheets covered with a scale .12 in. thick, the angle formed by the lines II and IV for .04 in. and .20 in. of scale respectively is bisected by the dotted line, and then the line II is lengthened out below, so that with the dot and dash prolongations it becomes the basis of the calculations (fig. 2, page 134); but as Hirsch's figures were obtained by experiments on open boilers and at a temperature of 212° F., about 180° F. has been added to these figures, as

found to correspond to the higher temperature of the steam. In the same way as for 31 the mean temperature of the corrugated flues was found, while for a steam generation of 56.6 lbs. per square foot (see 28) we obtain a temperature of 450° F., and as the steam temperature (see 30) is 387°, subtracting 180 leaves 207° to be added, which gives $450° + 207° = 657°$ F.

No. 32 is found in the same way as Nos. 29 and 30.

No. 33, the mean temperature of the outer shell, is the same as the steam temperature given in No. 30, less about 5 per cent.

No. 36, the relative expansion of the corrugated flue, is calculated from No. 34, the difference in temperature between the flue and the outer shell, the length of the flue as given in No. 9, and the coefficient $\frac{1}{1530}$, which is that for the expansion of wrought iron per 100° F. As an example for 36, we have $\frac{383 \times 132}{100 \times 1530} = .33$ in. for the first column.

No. 37 is calculated in the same way from Nos. 10 and 35, and is $\frac{168 \times 118.11}{100 \times 1530} = .13$ in. for the first column.

No. 38. The temperature of that portion of the corrugated flue lying beneath the grates is estimated to be about 54° F. higher than that of the outer shell, we therefore obtain 38 from No. 19 and find it to be $\frac{54 \times 88.6}{100 \times 1530} = .03$ in. for the first column.

No. 40. The temperature of the corrugated flue in the combustion chamber is taken to be the same, both at the top and at the bottom. No. 40 is therefore calculated from Nos. 20 and 34 as follows : $\frac{383 \times 43.3}{100 \times 1530} = .107$ in. for the first column.

No. 41 is found from Nos. 36 and 37, and is thus obtained for the first column $.33 + .13 = .46$ in.

No. 42 is derived from Nos. 37, 38, and 40 as follows for the first column.

No. 48. The expansion of the outer shell from the steam pressure acting longitudinally is calculated from the fibre stress, No 47 from the modulus of elasticity of 28,380,000 lbs. per square inch, and the total boiler lengths as taken from Nos. 9 and 10. For the first column of No. 48 the equation is $\frac{4821 \times 250.11}{28,380,000} = .0425$.

No. 49. The excess of compression at the top of the corrugated flue is equal to No. 41 minus No. 48. For the first column the equation is $.46 - .043 = .417$ in.

No. 50 is equal to No. 42 minus No. 48. For the first column the equation is $.27 - .043 = .227$ in.

No. 51 is taken from Table A with corrugated flues having corrugations 2 in. deep.

No. 52 is No. 51 times No. 8 (divided by 12) in inches.

No. 53. The expanding pressure of the corrugated flue upon the tubes is equal to the expansion of the flue at the top. No. 49 divided by No. 52 and multiplied by 20,000. For the first column the equation is $\frac{.417 \times 20,000}{.0163} = 511,656$ lbs.

No. 54 is calculated from the external diameter No. 3, from the external diameter of the tubes No. 12, the number of tubes No. 11, and the steam pressure No. 2.

No. 55 is equal to No. 53 minus No. 54, when No. 53 is greater than No. 54.

No. 56 is calculated from Nos. 11, 12, 13, and 55.

Nos. 57 and 58 result from the fact that No. 54 is greater than No. 53, and is calculated in the same way as Nos. 55 and 56.

No. 59. The shortening is estimated from the fibre stress No. 56, from the modulus of elasticity of 28,380,000, and the length of tubes No. 10. For the first column the equation becomes : $\frac{1925 \times 118.11}{28,380,000} = .008$ in.

No. 60. The lengthening of the tubes is calculated in the same way as No. 59.

No. 61 is equal to No. 49 minus No. 59, or plus No. 60 in case No. 59 is zero.

No. 62 is equal to No. 50, since the compression for the lower half of the corrugated flue is so much less than for the upper, and as this lower pressure is met by the steam pressure on the tube-sheet, and it thus comes about that no special pressure is brought against the tubes.

No. 63 is obtained from Table A for the corrugations 2 in. deep, and from Table B for the corrugations 3 in. deep.

No. 64 is No. 63 multiplied by the length of the corrugations No. 8 in inches, and divided by 12.

No. 65. According to fig. 3 we have placed the limit of elasticity of wrought iron at 60° F. at about 14,835 lbs. per square inch of section, while at between 550° F. and 700° F. it is only about 9,000 lbs. Now, since the corrugated flues in service are working at a temperature of from 550° to 700° F., and as Tables A and B are only calculated for 60° F., it is evident that a limit of elasticity must be adopted for these flues that corresponds to these high temperatures, since these alone are met with in service. Then, since $14,835 : 9,000 = 23 : 14$, we find the true limit of elasticity corresponding to No. 65 by multiplying No. 64 by $\frac{14}{23}$, which, in the case of the first column, becomes $\frac{.2825 \times 14}{23} = .1719$ in.

Nos. 66 and 68 are obtained from No. 61 minus No. 65, and will, therefore, be positive or negative according to the value of No. 66 relatively to No. 68.

Nos. 67 and 69 are obtained in the same way from No. 62 minus No. 65.

No. 70 is the minimum possible expansion allowable with the use of a flexible tube-sheet.

No. 71 is the maximum possible expansion allowable with the use of a flexible tube-sheet.

Now my proposition would be that instead of attaching the corrugated flue to a stiff ring we fasten it to an elastic one at the back end, as shown in fig. 16, page 168, which, according to my observations, should have a thickness of $\frac{1}{2}$ in , a breadth of $7\frac{7}{8}$ in., and a spring of about .4 in. without reaching the limit of elasticity, so that the tubes should be left perfectly free to expand and the corrugated flue itself be subjected to only a very slight compression.

It does not seem desirable to contract the back diameter of the corrugated flue, though it may involve increasing the diameter of the back end of the boiler if it is not done. It is only during a cold-water test that a pull will be exerted by the tubes, while they will be free to expand when in service, and the loosening of the tubes, which has been an objection to the stayless boiler, will no longer occur. At the present time there are 32 boilers built on my system in service in Germany ; there are a number in use in other countries ; some have recently been put out of service on the Prussian State railways on account of some inexplicable deformations, but I hope that as soon as I have put flexible rings in them they will be restored to service.

The question of longitudinal elasticity is a burning one for the whole range of technical boiler work, not only upon locomotives, but also in vessels and for stationary service. It is, therefore, not right to escape further trials by merely putting certain locomotives out of service, but rather carry the experimental work on so as to prove in the shortest possible time whether the flexible base ring will counteract this tendency to deform. In my opinion this is the case, and I can only urge that these investigations be continued.

On the other hand, an attempt is made to explain that the flattening of the corrugated flue is caused by its assuming an oval shape due to the unequal heating, and this has been observed to be the case in marine and stationary boilers. While this may be perfectly correct, we see the results, but not the reason.

In order to make the foregoing clear, let us take a lead pipe fastened at one end, and then having its upper half, corresponding to the excess of expansion of the corrugated flue, compressed longitudinally, it will then be under the same working stress as though we bent it upward, and it will then flatten on the top and show the same cross-section as the flattened corrugated flue.

If the corrugated flue is maintained at the same temperature all of the way around, even though the limit of elasticity may be passed and it may be upset, it will still retain the same circular form of cross-section as in the combustion chamber. In point of fact it is only above the grate that there is this one-sided compression and flattening, while the cooler portion remains nearly in its circular form.

Gentlemen, it is not my intention to handle exhaustively the details which I have investigated, as there is no time for that. Neither have I any intention of claiming a construction that has been absolutely perfected in the light of the defects that have been developed, but to assert that the design using a flexible head for express locomotives in conjunction with self-adjusting stay-bolts is a very great improvement ; I merely point it out as best may be and still remain on the outlook for further improvements.

In this paper I have attempted to show how defective our methods of boiler construction are, how necessary it is that they should be improved, and how it seems to me that this

end can be attained. On the other hand, I have desired to place my system of boiler construction, to which I have devoted a great deal of attention during the past five years, in a proper light before you, especially since the reason for the explosion at Bonn remained unexplained for a long time and was first cleared away by my efforts.

Had this boiler been fitted with flues having deeper corrugations with a depth of 3 in. instead of 2 in., or with a flexible back ring, as shown in fig. 16, page 168, so that the flue would not have been upset, it would not have been flattened nor collapsed, and the stayless boiler, which is considered to be the boiler of the future by many men in charge of railroad locomotive departments, would not have had the ban put upon it as now seems to be the case.

With this flexible ring the stayless boiler is perfectly free to expand internally, and this ring takes on the minimum flexure so readily, and the limit of elasticity is so far from being reached, that there is no possibility of a resultant danger. Furthermore, the construction of the boiler is as simple as it can well be conceived that a boiler can be, so that it is very much to be deplored that this type of boiler should have had such a set-back.

I hope that I have succeeded in convincing you of the accuracy of my reasoning, and of awakening an interest in the improvement in our boiler construction, and that by means of these improvements both our marine and locomotive boilers will be constructed in the future with a better regard to free expansion.

DISCUSSION.

Herr Bork: As it would occupy too much time to enter into a discussion of individual or comprehensive applications, I will confine myself principally to a brief exposition of the further adaptation of corrugated flue fire-boxes to locomotive boilers.

In regard to the testing of such an arrangement of boiler stay-bolts as will permit them to have a slight motion corresponding with the changes of temperature, it must not be allowed to pass unnoticed that such or similar constructions have been very frequently made, but that they have not, as yet, received a general application, because their use is often troublesome and expensive, and because of the difficulty of designing those that are suitable.

Again, as to the interpolation of a flexible ring between the tube-sheet and the shell of the boiler, it is, in my judgment, a faulty method of procedure, because there is neither any absolute necessity for it nor can any great advantages be expected from its use. Furthermore, if in the construction of a boiler the greatest possible care must be taken that changes of form can readily follow all changes of temperature without inducing any essential relaxation of the serviceability of the various parts of the boiler, this point must not be exclusively insisted upon, for there are many other points to be observed in securing protection against undue straining while in service and safety from explosions.

Should the proposed application of corrugated flues to locomotive boilers be carried still further, it might almost be predicted, in view of the explosion to which attention has been called, that its serviceable life would be still shorter. My opinion has already been confirmed by this explosion, which evidently did not occur through lack of water, that corrugated flue fire-boxes do not possess the necessary safety in adjustment and under varying pressures that it is necessary for those used in locomotives to possess. The author has endeavored to convey the idea that, with a somewhat different construction, the boiler will be made perfectly safe, and sets forth the opinion that, contrary to the ideas that have thus far been accepted, the corrugated flue offers a very considerable resistance to longitudinal compression. Consequently, as heating puts a longitudinal pressure upon the flue, it creates so great a bending moment that it actually does bend the flue, which in itself causes a further flattening and lessening of the cross-sectional area that finally results in a collapse. These distortions will, therefore, now be entirely obviated if, instead of fastening the corrugated flue directly at the back end, as has been done up to the present time, we make this attachment to the outer shell by means of a flexible ring, besides carrying the flue straight out to the end instead of contracting it.

If it can be conceded that with each faulty application of a contracted corrugated flue a bending moment is present, it is readily seen by closer observation that even with reference to the comparatively short arm of the lever upon which the longitudinal pressure acts, and the high moment of resistance of the cross-section of the flue, no appreciable bending and consequent flattening of the cross-section is likely to take place. It seems, furthermore, that the bending which occurs in the flue under normal working conditions is due solely to the influence of the unequal heating of those portions of the flue that lie above and below the grate, and were the ends of the flue to be perfectly free to move, it is probable that this variation of the cross-section from the truly circular form would be considerably greater. When we consider these changes of form, which cannot well be prevented in a corrugated flue, the proposed use of a flexible ring between the end of the flue and the outer shell would seem to have no influence whatever. Further, it is my unbiassed opinion that with the ordinary ring a far greater freedom of motion for the corrugated flue will result, because, in proportion to the number of corrugations, the flexibility of a ring appears to gain in safety from increasing thickness, and its capability of adjustment becomes of less importance. Again, the unequal heating of the top and bottom halves of the corrugated flue are entirely separate considerations, to which the dangerousness of such fire-boxes are traceable. The corrugated fire-boxes which are now applied to all boilers with circular fire-boxes are placed under contrary conditions to all the other circular portions of the boiler which are subjected to an internal pressure, in that they, when subjected to an equal strain on all parts, are not in a position to be forced back to their original circular form after any change in their shape has taken place.

With reference to the exceeding of the limit of elasticity, it is evident that the portion of the flue referred to will vary more and more from the circular form, while a flue subjected to an internal pressure will be forced back into the original circular form if by any chance it should vary from it.

In addition, the very great disadvantage under which a flue subjected to an external pressure labors lies in the fact that its tendency to a comparatively slight variation from the circular shape is considerably greater, since even in the original circular form there is an ever-present tendency, due to the strain on the several parts, to set up a bending moment. These supplementary strains increase in a direct ratio with the variation from a circular form, and are of such importance that, taking the measurements of the exploded boiler that has been cited as an example, we find that a steam pressure of only 160 lbs. per square inch under the conditions of only .6-in. of flattening, exerted a strain upon the summits of the corrugations that exceeded the limit of elasticity of the wrought iron. Starting at this point, under the influence of the normal steam pressure and the increasing influence of the temperature, it is possible that a marked deformation should take place which straightway led to a collapse, if a longitudinal increase in the dimensions of the flue does not take place.

The objection can be made that variations of .6 in. from the circular form can be obviated by taking greater care in the rolling and welding. On the other hand, it may be argued that absolute perfection in the formation of a circular corrugated fire-box is impossible of attainment, and variations of .6 in. in the construction are quite likely to occur. But even though the original form may have been exactly circular, it will not be long before, under the conditions of normal service, circumstances will arise under which a wide change of shape may result.

Then the changes of the circular shape are so conditioned that the inner surface of the upper half of the tube which is turned toward the fire has a somewhat higher temperature than that which is washed by the water, and will be increased by these working conditions if by means of a coating of grease or scale or any other influence the flames should produce a still higher temperature. Then it is, of course, evident, as has been already mentioned, in referring to the variations from the original sectional shape, that that portion of the flue lying above the grate has a markedly higher temperature than that which is below. This action has been detected by the corresponding inspections that were mentioned in the paper, that on measuring a number of corrugated fire-boxes, each of which had been in service but a short time, variations of 1.2 in. from the circular form were found. The great danger in the use of the corrugated fire-box may, therefore, be regarded as twofold.

It may be said that the raising of the duties of the locomotive will, in the first place, necessitate a further raising of the pressure of steam that is carried, and that this may possibly rise to 300 lbs. per square inch ; from which it is very evident that no corrugated fire-box can be used, since now, with a pressure of only 160 lbs., a terrible explosion has taken place.

After taking everything into consideration, I am of the opinion that, even with the changes that have been advocated here to-day, there can be no reason for the adoption or use of a corrugated fire-box, and that railroad managers who are impressed with the difficulties of the service will be led with

great difficulty to sanction any further changes in the designs of their locomotive boilers.

Herr Lentz: I must take exception to the statement of the gentleman who has just spoken in regard to the difficulty of making corrugated flues round. On the contrary, in the manufacture of corrugated flues, as carried on in the rolling mills of Schulz & Knaudt, these flues must be round when they come out of the rolls, and cannot be made in any other condition. Then, as it is easy to make such a flue exactly circular, it is exceedingly difficult to force it out of shape; to accomplish which a pressure of from 900 to 1,200 lbs. per square inch would be required. In the same way the material has the power of resisting a high degree of heat; even at a temperature of 1,100° F. the condition of the metal leaves nothing to be desired, since the tensile strength of wrought iron will still be 21,300 lbs. per square inch of section, while copper will have dropped to zero.

As for the changes in construction which I have advocated, and to which the gentleman has taken exception, I wish it to be understood that I have in no way maintained that the designs which I have submitted must be taken as models in all of their details; I have merely had the purpose in view of developing an improvement. I do, however, hold fast to the principles that the use of self-adjusting crown-bar stays and stay-bolts are of great value, and that nothing should be sanctioned, even though the change may appear to be an improvement, which complicates the construction, but does not make it better. I also disagree with the gentleman, if he means to say that the flexible ring, which I have used to increase the freedom of motion of the corrugated flues, does not fulfil this purpose. No limit is set to the flexibility of this ring; of course one cannot make it as thin as one may choose, but every metal is adaptable to this portion of the construction, even copper itself being unhesitatingly employed, provided that the temperature at the place where the ring is set is correspondingly low.

Finally, in the case cited by the gentleman, where it may become necessary to raise the steam pressure in locomotives, which will certainly be done, the difficulties that he will meet will lie in the fact that at the higher temperatures, which are inseparably connected with higher steam pressures, the strength of copper falls away in a very marked manner, so that it becomes practically out of the question to use it, while the corrugated flue, even at these high temperatures, has a strength amply sufficient to resist the strains that are put upon it.

TRIAL OF A SCHMIDT MOTOR (BOILER SUPERHEATER AND COMPOUND ENGINE).

Engineering of a recent date gives a summary by Bryan Donkin, M.I.C.E., of a report by Professor M. Schröter, of Munich, of an experimental test of Schmidt's superheated steam boiler, which was illustrated in the last and also in the February number of The American Engineer. In this report it is said:

"On the first day's trial the steam left the superheater at a temperature of 662°. The temperature of saturated steam at that pressure equals 374°, being a difference of 288°, the extent to which the steam was superheated. It entered the engine at a temperature of 604°, showing a loss of 58° in the steam-pipe. On the second day the temperature of the steam on leaving the superheater was 674°, or 300° of superheat, and it entered the engine at a temperature of 651°, or a pipe loss of 23°. This was due to the attention paid before the second trial to having the steam-pipes carefully covered. Too much stress cannot be laid on this point where superheated steam is used. A far greater economy than is usually thought possible may be obtained, even with saturated steam, by isolating the pipes, but with superheating, even with pipes of ordinary length, the whole advantage may be lost if the pipes are not carefully protected. The initial temperature of the steam in the high-pressure cylinder has a great effect upon the economy. The diminished consumption of feed-water in the second experiment—viz., 6 per cent.—as compared with the first, is ascribed by Professor Schröter to the increase in the temperature of the superheated steam from 604° to 651°. The hot gases in the flue fell below the temperature of the saturated steam . . .

"If an analysis be made of the way in which the boiler utilizes the heat contained in the coal, it will be seen that the use of the highly superheated steam is not only of advantage in a steam-engine, but that it can be generated without a large expenditure of heat. The temperature of the feed water is first raised by the heat of the gases about 108°; it is then converted into saturated steam, and the latter raised and superheated at constant pressure to a temperature of 651°. The amount of heat required per pound of coal to produce this result can be calculated with the usual formulæ, if the quantity of feed-water is known. The following table of the heat distribution in percentages shows that in the Schmidt motor as much care is bestowed upon generating the heat in the boiler as upon utilizing it in the engine.

		Per Cent.
Heat, July 30.	To evaporate the water into steam	63.7
	To superheat the steam	8.2
	To heat the feed-water	6.6
	Total efficiency	78.5

"The chief reason for the economical consumption of steam in this compound Schmidt engine is that all initial condensation in the high-pressure cylinder is avoided. By the peculiar arrangement of the cylinders the walls are surrounded continually with the steam of the receiver, with which the high-pressure cylinder is partially jacketed. Thus an exchange of heat is maintained between them and the working steam in this cylinder. The author, however, considers it possible that still greater economy might be obtained by some other method of construction, for according to the results here given a considerable exchange of heat also takes place in the low-pressure cylinder, in which external radiation may play a large part. Much, he thinks, still remains to be done with regard to isolating the cylinders by surrounding them with non-conducting materials. . . .

"Careful inquiry has shown that with similar engines after running some years no difficulty has been experienced with the pistons or valves due to working with highly superheated steam. This agrees with the results of experience in France."

SOME FACTS RELATING TO CERTAIN TYPES OF WATER-TUBE BOILERS.*

(*Continued from page* 164.)

UNIT NO. 4.

TUBES CLOSED AT BOTH ENDS.

There are only two ways by which boilers can be kept efficient and economical. The first is to feed them with absolutely pure water—practically a physical impossibility. The second is to arrange them so that the scale due to evaporation can be removed—that is, provide means which will give free access

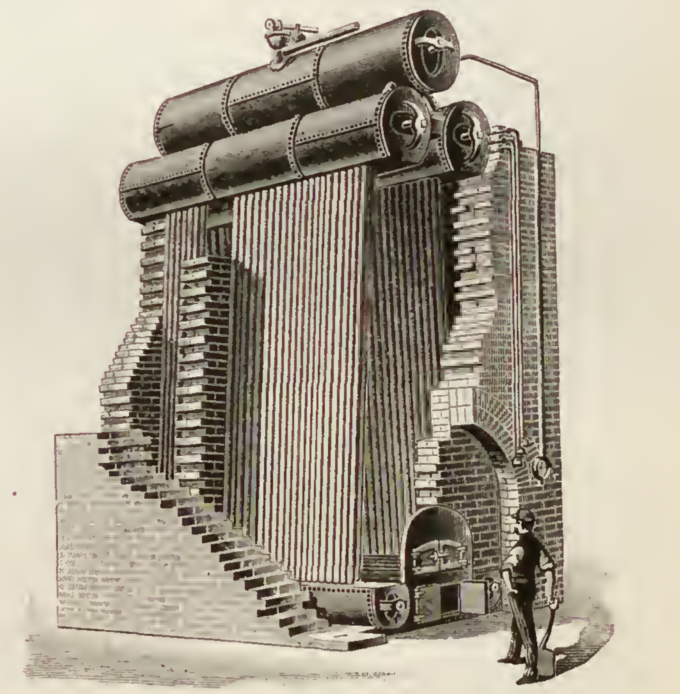


Fig. 35.—FIRMENICH BOILER, 1875.

From a Trade Circular Issued at Chicago.

to the tubes for cleaning every square inch of their internal surface. Unit No. 4 starts out all right with straight tubes, but ignores the essential point—facility of cleaning.

The **Firmenich** boiler (fig. 35) consisted of flat-sided horizontal drums at top and bottom of a bank of straight tubes.

* From advance sheets of a publication by the Babcock & Wilcox Company.

Two such units were placed "A" fashion, with the grates between them at the bottom, and surmounted with a steam drum on top. These tubes were inaccessible for cleaning.

If the drums were made round and the ends of the tubes

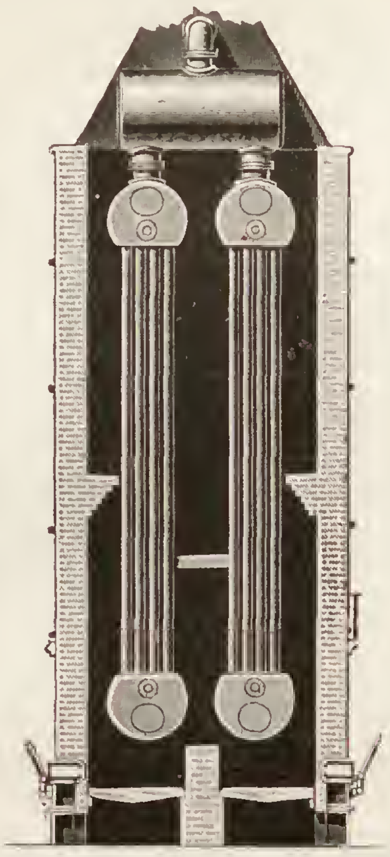


FIG. 36.—WHEELER BOILER, 1892.
From a Newspaper Clipping.

bent the units would strongly suggest several more modern boilers previously described (Stirling, Pierpont, etc.).

If the Firmenich units were placed vertical instead of at an angle, we have the **Wheeler** boiler (fig. 36), which came to us as brand new about the time the last of the Firmenichs was heard from.

The **Yarrow** boiler (fig. 37), is a slightly modified Firmenich (1875), in some instances made with small diameter drums

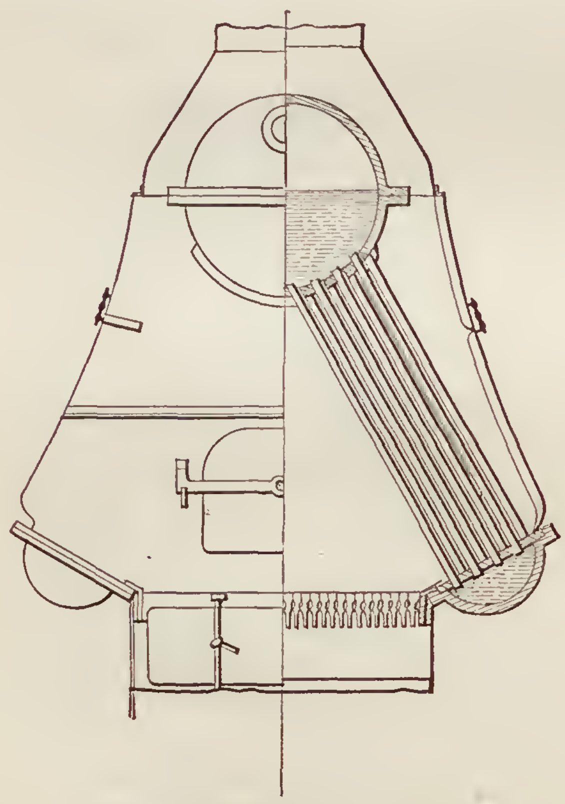


FIG. 37.—YARROW BOILER.
From Notes of Naval Progress, U. S. Navy, 1894.

bolted together in the centre, in larger sizes with the upper drums of sufficient diameter to draw the tubes into. As in all this class, the drums are greatly weakened by the large number and close proximity of the tube holes, and the sheet is liable to be strained or ruptured by expanding the tubes. When a tube leaks it is difficult to locate it, and hidden leaks are liable to cut out the metal. In the smaller sizes the tubes are accessible for cleaning by taking the boiler apart or by working in the dark and trusting to luck in the larger ones.

Babcock & Wilcox built a sectional boiler (fig. 38) with straight vertical headers. The tubes were brightened, laid in

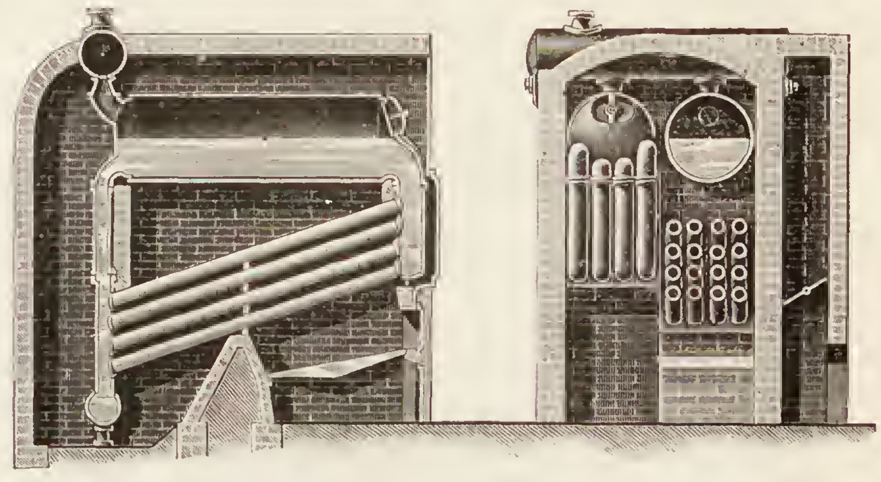


FIG. 38.—BABCOCK & WILCOX BOILER, 1868.
From the Original Drawings.

the mould, and the headers cast on. No hand-holes opposite the tubes were provided. It died very young.

Maynard (fig. 39) used a horizontal steam and water cylinder above a bank of tubes placed at a slight inclination from the horizontal; the ends of the tubes were expanded into

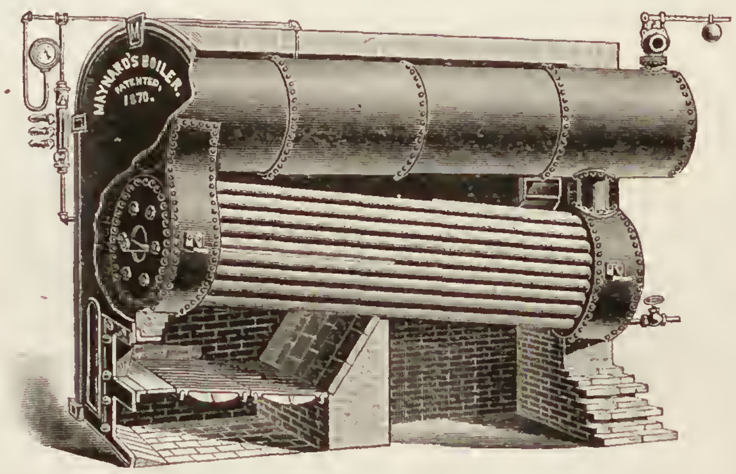


FIG. 39.—MAYNARD'S BOILER, 1870.
From a Trade Circular.

round boxes having stayed heads connected to a horizontal drum. The course of the gases was back and forth lengthwise of the tubes—in fact, a Heine boiler of earlier date without any hand-hole openings opposite the tubes.

If Maynard's top drum was cut off and one large tube was

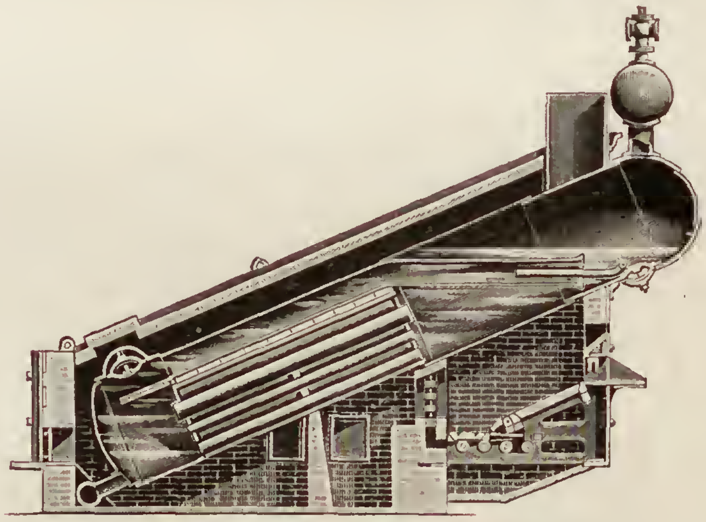


FIG. 40.—MEISSNER'S BOILER, 1882.
From a Trade Circular Issued at Philadelphia.

placed at the top of the bank for a return circulation and the front water-box was lengthened, we have **Meissner's** boiler (fig. 40).

Thompson (fig. 41) took one of Firmenich's sections, placed it in an inclined position, *à la* Maynard, beneath a return tubular boiler, and connected them at front and rear by a supply and delivery pipe.

If a round neck were substituted for the flanged neck at the

front of Maynard's design, we would have the **Wood** boiler (fig. 42).

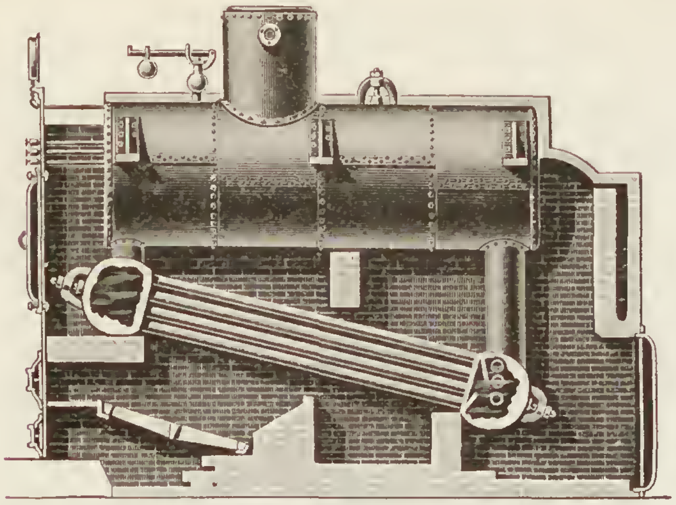


FIG. 41.—THOMPSON'S BOILER, 1884.
From a Trade Circular.

By putting Meissner's return pipe outside and rechristening it we have **Black's** boiler (fig. 43).

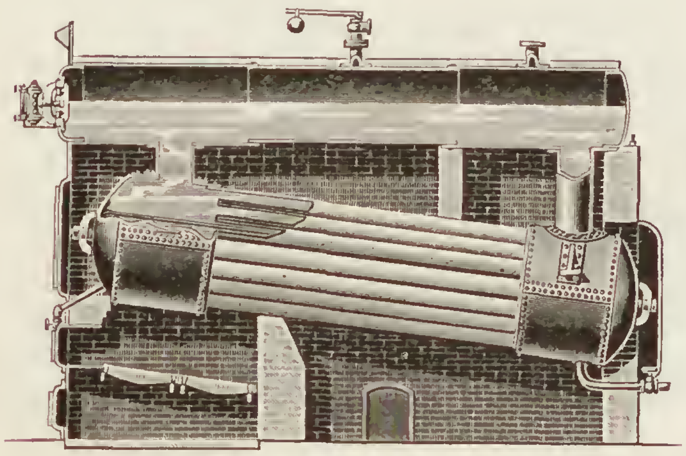


FIG. 42.—WOOD'S BOILER, 1889.
From a Trade Circular Issued at Conshohocken, Pa.

Stand Meissner's boiler vertically, put the return pipe in the middle instead of at the side, and we have **Cook's** boiler (fig. 44).

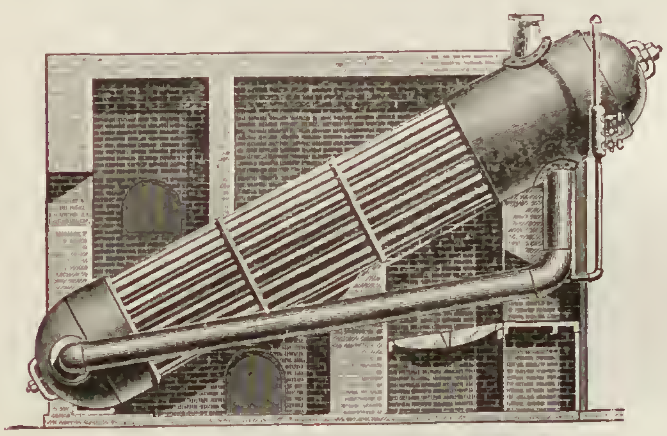


FIG. 43.—BLACK'S BOILER, 1890.
From a Trade Circular Issued at Baltimore, Md.

FIG. 45.—HENSHALL'S BOILER, 1892.
From a Trade Circular Issued at Tremont, Pa.

Henshall (fig. 45) took Meissner's boiler for a top drum and Cook's boiler for a lower drum, placed them in the same relative position as Maynard's two principal units, and connected them at the ends by circulation pipes.

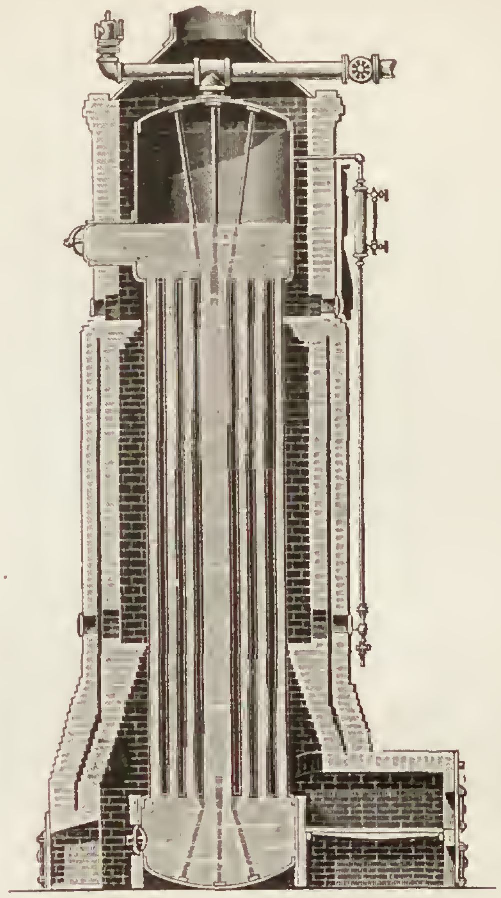
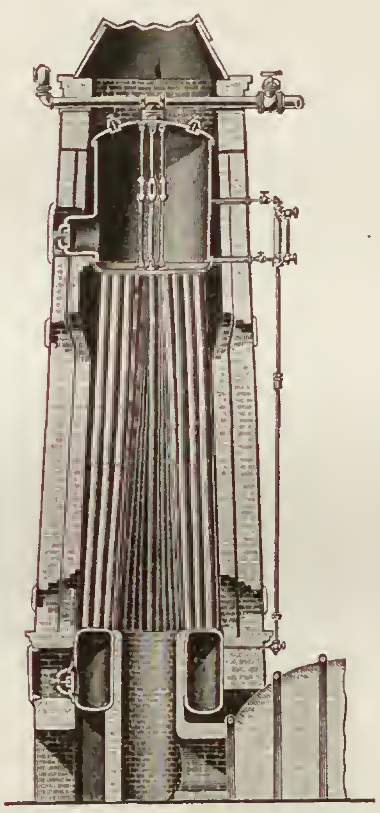


FIG. 44.—COOK'S BOILER, 1891.
From a Trade Circular Issued at Mansfield, O.

If the large central pipe is taken out of Cook's boiler and a piece is cut off and used for a flue through one of the drums,



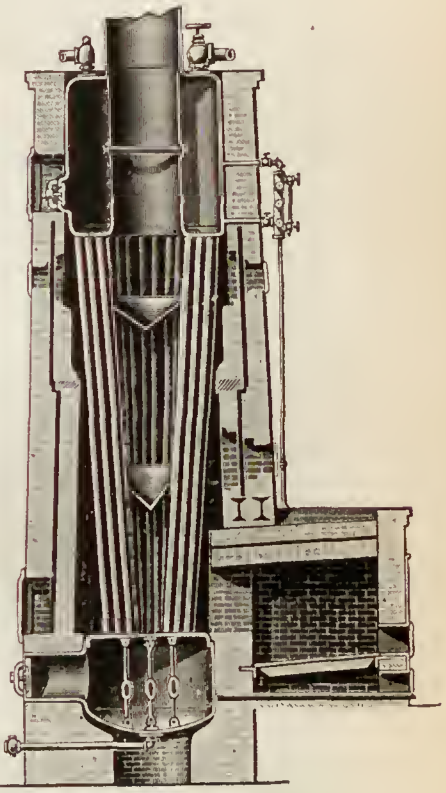


FIG. 46.—CAHALL'S BOILER, 1892. FIG. 47.—CAHALL'S BOILER, 1892.
From a Trade Circular Issued at Mansfield, O.

we have the **Cahall** double-header boiler (figs. 46 and 47), built so it can run either end up.

"He stood a spell on one foot fust,
Then stood a spell on t'other;
And on which one he felt the wust
He couldn't told ye nuther."

MORAL.

When one considers that the boilers described are only a small fraction of the different kinds offered to the public as "self-cleaning," is it any wonder that for many years the merits of patent boilers were classed with those of patent medicines and lubricating oils?

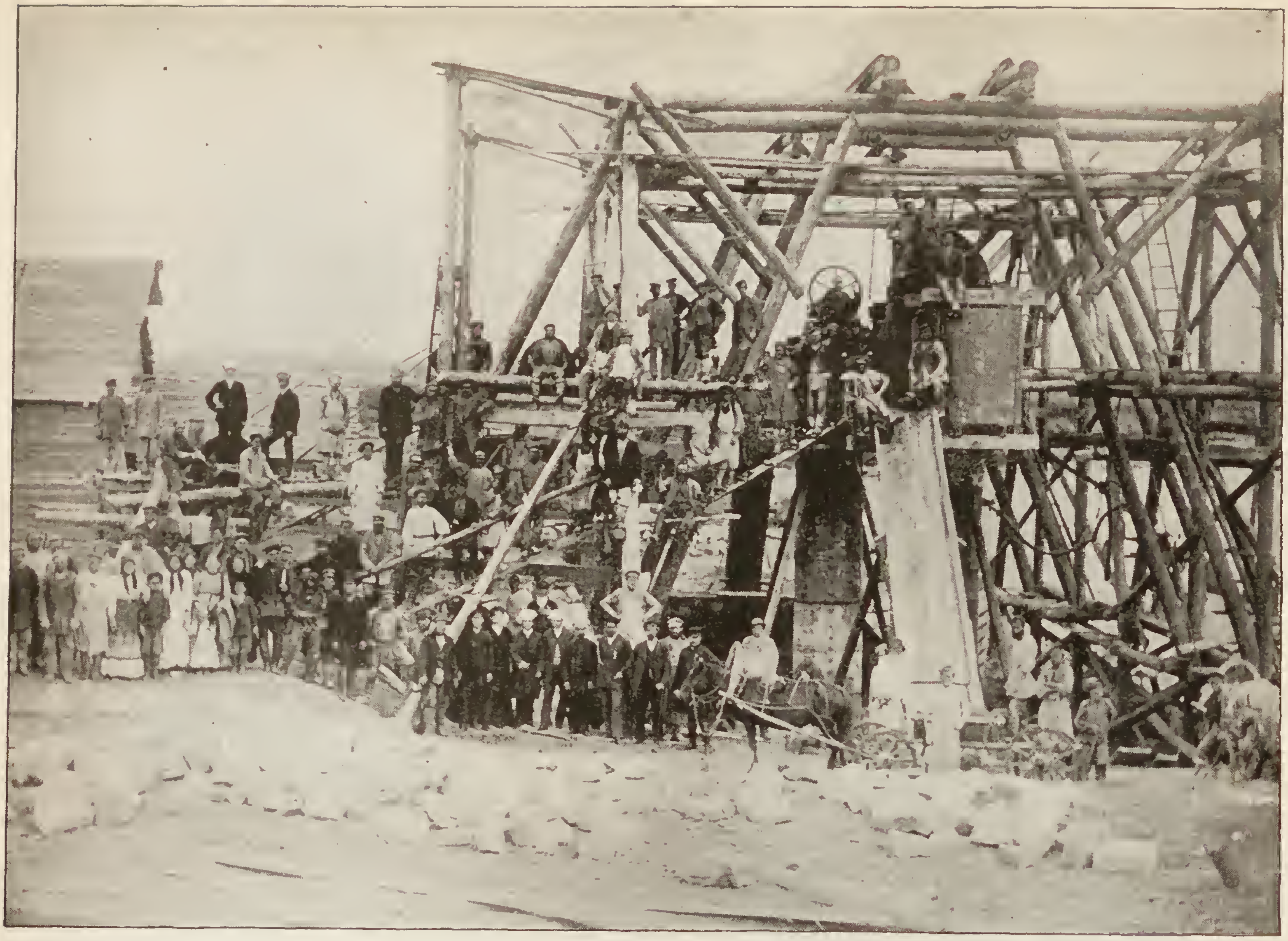


Fig. 15.—Construction of the Tobol Bridge, Sinking of Caisson, Falsework, Sluices and Transportation of Earth.

Fig. 16.—Mounting of the First Span of the Tobol Bridge in Kourhan, of which there are Three Spans of 350 ft. each.

THE TOBOL BRIDGE ON THE GREAT SIBERIAN RAILROAD.

THE GREAT SIBERIAN RAILROAD.

The following interesting account and the two accompanying views (figs. 15 and 16), showing the progress of this great work, will interest many of our readers. The opening of this line, combined with the results of the Japanese-Chinese war, will be an epoch in the world's history the ultimate results of which no one can even imagine.

The construction of the Great Siberian Railroad has entered upon a new phase. Up to the present time it has been controlled by the Siberian Railroad Committee, presided over by the successor to the throne, Nicolas. In the twentieth session of the committee, however, which was the first after the Czarevitch Nicolas had ascended the throne, the new Emperor proclaimed that he would retain the presidency of the committee in the following language:

"Gentlemen, the institution of the construction of a continuous Siberian railroad is one of the great deeds of the glorious reign of my unforgotten father. To complete, with the help of God, this exclusively pacific and civilizing enterprise is not only my holy duty, but my hearty desire; the more so because it was intrusted to me by my dear father. I hope, with your assistance, to rapidly complete the construction of the Siberian Railroad which was commenced by him."

The vice-president of the committee, Mr. Bunge, in the name of the committee, answered in the following manner:

"We are happy that by your high will the construction of the Siberian Railroad still remains under the immediate control of your Majesty. When you were at Vladivostok your Majesty laid the first foundation of the railroad now being constructed through Siberia. After your return the late Emperor appointed you the President of the Committee of the Siberian Railroad, and by this means guaranteed the accomplishment of the task intrusted to the committee and assisted by your permanent aid. Now that your Majesty has deigned to keep in your hands the control of this great enterprise, designed to join European Russia with the Pacific coast, we are sure that the great enterprise bequeathed to your Majesty by your late father will soon be brought to the happy end, and will be the glory of the present reign as well as of the one that is past."

After this speech the Emperor proposed to the committee to deliberate on current business.

The first question of assignment of expenses for the construction of the railroad in 1895 was only mentioned, the special estimates not being as yet ready. It was suggested, however, that the estimates should be prepared with the greatest possible economy.

Then the preparatory commission for the auxiliary enterprises connected with the construction of the Siberian Railroad appropriated 351,000 roubles for the emigration of casaks (half settlers, half soldiers) from European Russia in the Amour territory, and 86,000 roubles for the transportation of 150 casaks' families belonging to the Transbaïkal militia, in the region of the Oussouri Railroad. This last measure was proposed by the Minister of War, in order to protect the Oussouri Railroad against the Chinese robbers and highwaymen.

At the close, the general data about the state of construction was considered. This data is as follows:

The first division of the Western Siberian Railroad, from Chelabinsk to Omsk, has the earthworks and small timber bridges completed. The three great bridges through Tobol, Ishim and Irtish are under construction. The first was to have been completed in March, 1895, the second in September, 1895, and the third in 1896. The track is laid on the whole division from Chelabinsk to the Irtish River (495 miles), and the telegraph line is ready. Of the "line" buildings, 60 per cent. are ready; of the station buildings, 50 per cent., and of the water-supply buildings, 66 per cent. For the provisional traffic 34 per cent. of the locomotives and 96 per cent. of the cars are supplied.

On the second division of the Western Siberian Railroad, from Omsk City to the Obi River, there is completed 72 per cent. of the earthworks, 15 per cent. of the small timber bridges, 33 per cent. of the "line" buildings, and 8 per cent of the station buildings. The track is laid on 66 miles, and 25 per cent. of the rails and 40 per cent. of "accessories" have also been supplied. Of the rolling stock, 16 per cent. of the locomotives and 56 per cent. of the cars have been delivered. Of course this condition of the work guarantees the completion of the Western Siberian Railroad in 1896 or possibly sooner.

The first division of the Central Siberian Railroad, from the Obi River to Krasnoïarsk, has only 38 per cent. of earthwork ready. Besides that, 27 per cent. of the small timber bridges, 30 per cent. of the "line" buildings, 10 per cent. of the water supply buildings, and 80 per cent. of the stone culverts are under construction. The track is laid on 200 miles, and 17 per cent. of the locomotives and 42 per cent. of the cars are supplied.

On the second division of the Central Siberian Railroad, from Krasnoïarsk to Irkoutsk, and the branch to Tomsk City, only the final location is completed, and the earthwork is begun.

The improvement of the comparatively unknown Siberian rivers Chulim and Angara has also been begun under the control of the Chief Engineer of the Central Siberian Railroad.* Chulim River for its 200 miles is cleared of stumps or "snags." On the Angara River the chief falls have been surveyed, and six steamers (four towing steamers and two ordinary scows) have been delivered.

The North Oussouri Railroad (from Grafska to Khabarovsk) and the branch Chelabinsk-Ekaterinburg are located, and the earthwork is begun.

The construction of the South Oussouri Railroad, from Vladivostok to Grafska (or Mouraviev-Amoursk), is completed (252 miles).

In all, the length of the track laid on the Siberian Railroad is now 1,012 miles, which is less than one quarter and more than one-fifth of the whole length of the Siberian main line (4,550 miles).

The twenty-first session of the Committee of the Siberian Railroad of January 4, 1895, presided over by the Emperor Nicolas, was very interesting.

In the paper presented by the Minister of War it was stated that in 1894 great topographic surveys were made. Five parties of military topographic engineers surveyed about 15,000 miles in the region of Transbaïkal Railroad, and plotted it on a scale of $\frac{1}{84000}$. Furthermore, the engineers of the Irkoutsk and Amour division have surveyed the region of the Baïkal Loop Railroad and of the Amour Railroad. All of these topographic surveys were made principally for the sake of the better location of the railroad, and therefore in connection with the surveys of railroad engineers. In addition to these, the engineers have described the climate, population, and agricultural possibilities of the country. The geographic situation of Verkne Oudinsk and Kaïdalovsk has been determined astronomically, the longitude by means of telegraph, and 29 other points by means of chronometric expeditions.

In the year 1895 the topographic surveys will be continued in five regions: 1. Along the Baïkal Loop Line and along the shore of Baïkal Sea to the harbor of Listvenniehnaïa. 2. From Misovskaïa (eastern shore of Baïkal) to Pokrovskaïa (the point where the Shilka and Argoun form the Amour River); along the Transbaïkal Line. 3. From Pokrovskaïa to the Zeïa River (a tributary of the Amour). 4. From Zeïa River to the Bureïa River (also a tributary of the Amour). 5. From Boureïa eastward. The credit required for these topographic works will be 143,000 roubles (in 1895).

The Minister of Finance (Mr. S. Witte) has made a very important statement concerning the construction of the Amour Railroad. According to the last information, the first division of the Amour Railroad, from Sretensk to Zeïa River, is the most difficult. Therefore, and in order to hasten the completion of the Siberian main line, it is necessary to make the surveys and location of the second division eastward of Zeïa, from Blagoveshchensk to Khabarovsk, at once, so that, when in 1896 the earthworks on the North Oussouri Line are completed, the construction of the second division of the Amour Railroad (which is easier to construct) can be begun.

The Minister of Agriculture and State Properties (Ermoloff) presented an account on the geologic surveys of 1893 and 1894, and asked for 139,000 roubles for the same purpose in 1895. This sum was appropriated, with instructions that the geologic explorers shall chiefly search for coal which can supply the mineral fuel for the Central Siberian and Western Siberian Railroads. During the geologic surveys of 1893 and 1894 the following useful minerals were discovered: 43 mines of lignite and coal, 15 placers of gold, 36 copper ore deposits, 10 iron ore deposits, 2 lead ore deposits, 2 deposits of graphite, 1 petroleum deposit, 2 manganese ore deposits, and 1 silver ore deposit. It is most important to find mineral fuel, which can be supplied to the Western Siberian and Central Siberian Railroads, and this will be the chief aim of the geologic surveys of 1895.

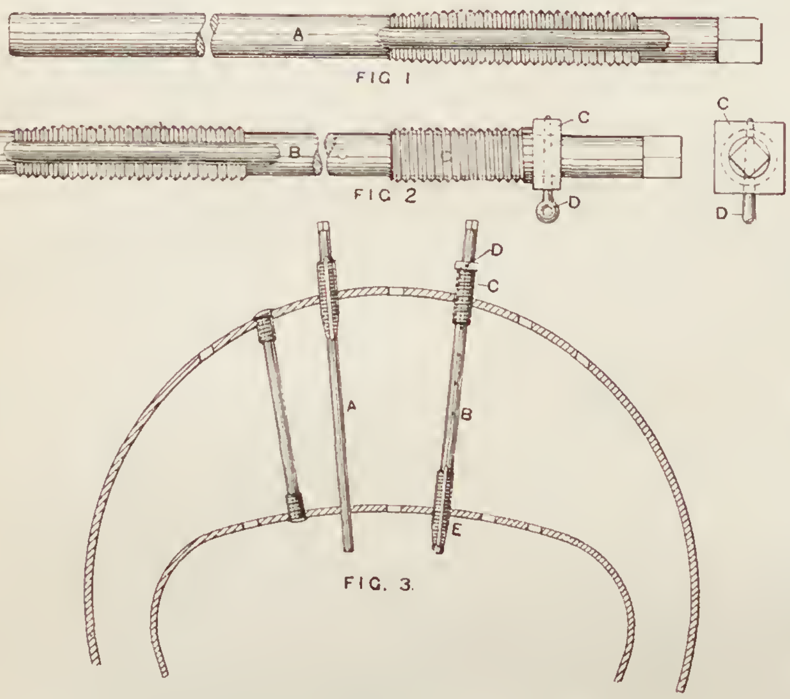
The whole length of Russian railroads is now 23,113 miles, of which 20,813 miles belong to the Government and are under the control of the Ministry of Ways of Communication, 899

* The rivers Chulim and Angara are very important for the Central Siberian Railroad, being designed as waterways for supplying the rails and other railroad materials. Chulim River, a tributary of Obi, will serve for carrying rails from the Oural Steel Works to Achinsk. Angara, connecting the Baïkal Sea with Yenisseï River, will carry rails to Irkoutsk (the eastern terminus of the railroad).

miles under the Ministry of War, and 1,401 miles to the Finland Government. During the year 1894 the State acquired the following railroads, from the great Society of Russian Railroads: The Nicolaï Railroad (St. Petersburg-Moscova), the St. Petersburg-Warsaw Railroad, and the Moscova-Nijni Railroad, in total 1,495 miles; the Riga-Dunaburg and Riga-Bolderan Railroads, 143 miles; the Mitau Railroad, 85 miles; the Rjev-Viazma Railroad, 77 miles; the Orlov-Vitebsk Railroad, 325 miles; the Dunaburg-Vitebsk Railroad, 163 miles; the Novotorjck Railroad, 85 miles, and the Lozovo-Sebastopol Railroad, 503 miles.

TAPS FOR CUTTING THREADS FOR STAY-BOLTS.

Figs. 1 and 2 represent taps which are used in the Baltimore & Ohio Railroad shops for cutting threads for stay-bolts in the plates of locomotive fire-boxes. Their operation will be understood from fig. 3. In the latter the tap represented by fig. 1 is shown at *A*, and is used for cutting the thread in the first or outer hole. This tap, it will be seen, has an extended shank, which is inserted in the hole in the inner plate while the thread in the outer one is being cut. The direction of the tap is thus guided by the inner hole, which insures that the thread will be cut so that its axis will coincide with the centre line of the two holes.



STAY-BOLT TAPS, BALTIMORE & OHIO RAILROAD.

When the thread in the outer hole is cut the tap represented by fig. 2 and shown at *B* in fig. 3 is screwed through the outer hole, and its lower end is then inserted in the hole *E* in the inner plate. It will be seen that this tap has an extended shank on its upper end. When its lower end has been inserted in the hole at *E*, a sleeve, *C*, is slipped on the upper end. This sleeve has a screw cut on its outer surface which is screwed into the upper hole. The sleeve also has a collar on its upper end, with a transverse hole, *D*, drilled in it, which may be made to coincide with similar holes drilled in the shank of the tap. When the sleeve has been screwed into the outer hole until the hole in the collar and one of those in the shank of the tap coincide, a pin, *D*, is inserted in these holes, which holds the two so that they will turn together. Then by revolving the tap its lower threaded end will cut a thread in *E*, which will coincide with that in the outer hole. After the tap has taken hold in the inner hole, the pin *D* is removed, which will allow the tap to revolve within the sleeve.

These tools, it will be seen, save the time consumed in screwing an ordinary tap its whole length through the outer hole, and protect the thread in the outer hole from being unduly enlarged thereby.

WATER-TUBE BOILERS IN THE BRITISH NAVY.

On a motion for going into Supply on Navy Estimates in the House of Commons recently, the subject of Water-Tube Boilers was made a subject of special consideration, and a very interesting discussion followed, which has since been succeeded by a number of letters from prominent engineers which have appeared in *The Times*. As this is a matter which is receiving special attention in this country as well as on the other side of the Atlantic, the following extracts from the discussion and from the correspondence are given, and will no doubt be of interest to many of our readers.

In discussing the measure referred to, Mr. W. Allan, of Gateshead, said that the sole value of a man-of-war as a fighting vessel lay in the boilers, for if they failed the ship stopped. The great weakness of their Navy was due to the simple fact that there was a deficiency in the boiler power on board the vessels. The Admiralty had been trying for years to get 1 H.P. out of 1¼ sq. ft. of heating surface, whereas it required 3 ft. to give such a power. By adopting this method they had rendered every ship in the Navy absolutely useless for full steam speed. The boilers were too small, and when it was endeavored to get more power out of them than they were capable of giving, the strain was too great for them to bear, and the boilers became practically useless. The three vessels, the *Blake*, the *Vulcan*, and *Blenheim*, were not four years old, and yet £120,000 was required to re-boiler the vessels. Was not that a squandering of national money? The vessels were puffed tremendously, but as soon as they went to sea the boilers completely failed. How long did the Admiralty intend to pursue this suicidal course? How long did they intend trying to get more power out of the boilers than they were capable of giving? He could only say that as long as they did so the ships of the Navy would be endangered in time of war—they would never be able to pursue an enemy or to run away from one. (Laughter.) Locomotive boilers had failed, and the Admiralty had now been driven to the adoption of water-tube boilers. But why need they have done this when even better results might have been obtained by a safer, simpler, and more economical method? His object in bringing this matter forward was the safety of our ships—the desire that our ships should be in every sense of the word first-class fighting machines. In his own experience these water-tube boilers had been tried over and over again in the mercantile marine, and they had always failed; indeed, he challenged any one to bring forward a case in which they had not failed. Yet the Admiralty had adopted them on the slight recommendation of a French engineer, who reported upon the water tube boilers in one of the vessels of the Messageries Maritimes. But did that engineer report on all the mishaps and repairs which those boilers involved, the number of spare tubes which it was necessary to carry in case of failure, and the cost they involved in the great consumption of coal? Simply upon the report of this Frenchman the Admiralty were now plunging into water-tube boilers for several of the splendid cruisers which were being built. The number of explosions which had occurred through the use of these boilers and the number of fatal accidents in connection with them were distressing. There was the case of the torpedo-boat *Sturgeon*, which was fitted with these boilers, and soon after proceeding to sea an explosion of one of the tubes occurred, killing an engineer and four men in her stokehold. These tube boilers were deemed so dangerous by a firm of shipbuilders at Barrow that the lives of engineers and stokers were insured on trial trips for £400 by the firm and provision was made in case of their disablement. Take the case of the *Hornet*. They had all heard of her performances; of how she could steam from 27 to 30 knots. Where was she now? Lying in a corner of Portsmouth Dockyard, and her boilers, only 12 months old, out of her for repair. He believed that if a return was prepared it would be found that hundreds of thousands of pounds were squandered on experiments of this kind. This was not the engineering of Great Britain—of James Watt and George Stephenson. It was the engineering of some belated and interested Frenchman. These boilers were not economical, and the aim of the Admiralty ought to be how to save coal, because the less coal they burned the fewer men would be required and the greater steaming power the vessel would possess. He could not discover the advantages of these tubular boilers. They gave less safety, less efficiency, and greater complexity. And, after all, the guns and armor of a ship were of little value if the boilers were not to be depended upon. Who was responsible for that state of things? Was it the First Lord? No; he was not an engineer. Was it the Secretary to the Admiralty? No; he was not an engineer. Was it the Civil Lord? No; he was not an engineer; he knew nothing about engines. (Laughter.) Was it the Chief Constructor of the Navy? No; he was only a shipbuilder, though a very clever one. (Hear, hear.) He wanted the Civil Lord to tell the House upon whose shoulders rested the responsibility for the water-tube boilers fitted into the torpedo-catchers and other vessels of the

Royal Navy. That was the question which he wanted an answer to. (Hear, hear.) It was a mixed-up affair, but he was determined to get at the bottom of it and to find out who was really responsible for this engineering. (Cheers.) He bade the Admiralty pause before embarking on such a huge experiment. He implored them, as an engineer, to test these boilers for themselves before fitting them into their two grandest cruisers. He would like the boilers to be first fitted into a second-class cruiser, and then have them tried at sea—not merely for a couple of hours' run, with a few newspaper correspondents on board, but running at sea till the coal was exhausted; and then, after taking in a fresh supply at some coaling station, to steam home again. Let this be done in the presence of competent experts; let the latter make a full report upon the boilers, and let that report be laid upon the table of the House. (Hear, hear.) Honorable members would then be in a position to judge. The Admiralty owed that duty not only to themselves, but to the country and to the men on board those ships. (Cheers.) If these boilers were so commendable, how came it that no shipowner in the House had adopted them? There was, he asserted, not a shipowner in Great Britain who would put into two such splendid cruisers as the *Powerful* and the *Terrible* 48 water-tube boilers apiece. Then, why should the Admiralty do it? Simply from the fact that the money was found for them to squander. (Hear, hear.) He warned the Admiralty that they would, if they persisted in their present course, be landed in endless expense, unless, indeed, some terrible disaster overtook those vessels such as happened to the *Victoria*. He had considered it to be his duty, not only to his constituents, but to the House and the country, to put forward his views on the present occasion. (Hear, hear.) He did not wonder that the Admiralty could not get engineers to go on their ships, though they were advertising for men in all the towns in the Midlands. Why? Because it was well known to engineers throughout the country that the poor men at Barrow had to get a life-policy before they would go on boats fitted with the water-tube boilers. The Government should no longer wonder why they could not get men for their ships when they put such dangerous fittings into them (Hear, hear.) He considered it a duty which he owed to the Admiralty themselves thus to speak his mind on a subject which was fraught with the gravest import to the strength and efficiency of our Navy, and to the credit of British engineering. (Cheers.)

Mr. Forwood remarked that he was sure the House had listened with great pleasure to the speech just delivered. (Hear, hear.) The honorable member for Gateshead had dealt with a technical subject, and one very difficult to bring home to lay minds, in a most picturesque and interesting manner, and he was sure that the words which had been uttered by him were weighty ones and well worthy of serious and anxious consideration. He only regretted that the honorable member had not been present when the estimates for the construction of the *Powerful* and the *Terrible* were first brought up. On that occasion he expressed an opinion on these water-tube boilers, not certainly on the lines of the honorable member for Gateshead, but anxiously pressing on the government to have them first tested on a smaller and less important vessel; and, as a shipowner and a layman, he was certainly of opinion that the government ought not to have put these boilers into our two biggest cruisers till adequate trials had been first made in a smaller vessel. An engineer officer was sent out as a passenger by one of the boats to see how these boilers worked, and he made a very valuable report, but the *data* was not of the kind on which the Admiralty could embark with experiments. The only advantage was that they lend themselves to be placed in a ship, and stood more conveniently than ordinary cylindrical boilers. He should like to say that one of the last actions of his noble friend, when chief of the Admiralty, was to order a torpedo-boat with a water-tube boiler for experimental purposes. The order was given to Thornycrofts, and they were given a free hand. They guaranteed that the boiler would be efficient for at least three years. He thought that was a proper course to take, and it was right that the Admiralty should watch all new inventions. The member for Gateshead had made a sweeping attack upon the boilers generally in her Majesty's ships, and if that attack were passed over it might cause alarm. There was no doubt that at one time there was an inclination to cut down the size of boilers and force them to give larger H.P. than, as it had since been proved, was practically possible. They had then at the Admiralty probably the most able theoretical engineer that ever lived, but his great *forte* was theory rather than practice. His great desire was to unduly cut down engines and boilers, in order that a vessel might hope to be propelled at a higher rate of speed and be built on finer lines. The result of that policy was that several vessels, the *Blenheim*, the *Blake*, and the *Vulcan*, had not proved satisfactory. The boilers would not stand the forced draft for which they were originally designed. When the Naval Defence Act vessels were laid down it was decided that the boiler power of those vessels should be as near as possible on the lines adopted by the mercantile navy.

Mr. Penn did not think that the alarm expressed by the honorable member for Gateshead (Mr. Allan) in reference to the boilers in the Navy was well founded. His own impression was that as at present designed we did not get enough out of the boilers. It would have been well to have given a longer trial to the water-tube boilers of the Belleville type, but it should not be supposed that these were so many death traps. They had been running now for several years, and would have been condemned long ago if they really were the failures the honorable member seemed to think.

Mr. Robertson said this case of water-tube boilers was an example of the extent with which the Board of Admiralty, whether the naval or civil element was concerned, must be guided by the best professional advice it could obtain. There were hundreds of questions in the administration of the Admiralty with which his honorable friend was not familiar, on each of which they must be guided by professional opinion; but referring to the engineering advisers of the Admiralty, his honorable friend spoke of them as belated something or another. (Laughter.)

Mr. W. Allan: "No; I never used such a phrase as that. I merely wanted to know who was responsible for the adoption of the Belleville boilers to such an extent."

Mr. Robertson: "Certainly, I am going to answer that question. His honorable friend was himself a little belated in bringing this question before the House, because the adoption of the Belleville boiler was no new thing. It was mentioned a year ago to the House of Commons, and was matter of notoriety in all sorts of ways. Not long ago the Engineer-in-Chief of the Navy read a paper before the Society of Civil Engineers, in which this matter was expounded before experts and people of skill, and the thing passed apparently without discussion, certainly without disapproval, among men who were entitled to speak with as much authority as his honorable friend. The history of the subject, so far as the Admiralty were concerned, was this. In 1885 a torpedo-boat was first of all fitted with these water-tube boilers. In 1888 three torpedo-boats meant for Indian service were similarly dealt with. In 1892 another torpedo-boat was fitted in like manner. In 1891 the *Speedy* was fitted with water-tube boilers with satisfactory results, and in 1892 the Boiler Committee, which gave special advice to the Admiralty, recommended the adoption of these boilers for the new cruisers, and the *Sharpshooter* was fitted with Belleville boilers and another vessel with water-tube boilers of another type. Then the Admiralty sent out that despised Frenchman—who, by the way, was no more a Frenchman than the honorable member for Gateshead was (laughter)—they sent an engineer officer to examine the working of these boilers on board the large ships belonging to the Messageries Maritimes, and that officer no doubt spoke French; but, as he was to be on board French ships and to talk to French engineers, they considered that that was rather a qualification for his mission. (Laughter.) This officer went to Australia and back, and his report on the working of these boilers was entirely satisfactory. The next step was that the Committee on Machinery Designs expressed satisfaction at the proposal to use Belleville boilers for the *Powerful* and the *Terrible*. In the circumstances he could not see how the Admiralty could have acted otherwise than they did. Sir William White's opinion was in favor of these boilers, and the House, he was sure, would receive with respect his testimony, even on a point of technical engineering. But there was a more important authority still—namely, the Engineer-in-Chief of the Navy, Mr. Durston, who was really responsible for the adoption of these boilers. The Admiralty, he affirmed, had dealt with this matter as they were bound to deal with all technical matters. He would say, generally, however, that the honorable member for Gateshead was wrong in what he had said respecting the *Blenheim*, the *Viking*, the *Blake*, and the *Hornet*. He trusted that the House would be of opinion that he had vindicated the action of the Admiralty, inasmuch as he had shown that the Board had sought the best advice obtainable, and had acted consistently upon it. The Admiralty were told that the benefits of these boilers were higher steam power, less weight for a given steam power, and greater command of steam. Those were specific advantages of which they had professional assurance, and on that assurance they had been introduced into these large ships."

Lord G. Hamilton wished to know if the statement that the boilers had been taken out of the *Hornet* was true.

Mr. Robertson said that the tubes were being changed to steel. That was going on while the vessel was under repair.

Mr. W. Allan asked whether it was not the fact that the boilers were lying in a corner of the dockyard, and the ship open and practically gutted.

Previous to this discussion, in reply to a question by Mr. Gourley, Mr. Robertson stated that of the 42 torpedo-boat destroyers completed and building, all except six are and will be fitted with water-tube boilers. The boilers of nine of these ships were fitted with copper tubes throughout by the contractors, who were responsible for the design and preferred to use that material. In three of the last-named, on the contractors' preliminary trials, failure of the copper tubes occurred in positions most exposed to the fire, and in one case was attended with fatal results. It was consequently decided to avoid further risk by substituting—entirely in some of these vessels and to a large extent in the others—steel tubes for copper.

Lord George Hamilton said: "I should like to say a word as to the question raised last night by my honorable friend, the member for Gateshead. My honorable friend attacked the Admiralty for having adopted water-tube boilers. If anybody was responsible for the introduction of these boilers it was myself. And I will state my reasons. An extraordinary improvement has taken place in marine engineering in recent years. But the improvement in boilers has not in any way corresponded to the improvement in machinery. Various experiments to get increased boiler power into torpedo-catchers have not been successful, and therefore it seemed to me that when a firm of high repute guaranteed efficiency for three years it was worth while making the experiment, and the ship intrusted to this firm has been a very great success. My honorable friend drew a pathetic picture of the terrible dangers to which any one was subject who went on board a vessel with water-tube boilers. I have been on board such vessels, and I believe a water-tube boiler is just as safe as any other boiler, provided it has been properly manufactured and is properly managed. The mistake made in this matter arose because the Admiralty had to put out a very large number of torpedo-boats all at once, and they were compelled in consequence to distribute them over many firms who had never built a torpedo-boat before. All the accidents that have occurred were in the work of firms who had no experience of this particular class of boilers. Therefore, I cannot blame the Admiralty. I think they were right in continuing experiments as regards water-tube boilers. They have put them into two of the largest cruisers ever built, and if the result justified that experiment no fault could be found."

Mr. Wolf thought that in the question of boilers, so far as his professional knowledge went, tubular boilers had no advantage over ordinary boilers, except that they were a saving of weight. In his opinion the Admiralty were making a most unwarrantable experiment with the Belleville boilers. He never heard of any commercial company that would at once apply one new boiler to the whole of the ships they were going to build. Surely the Admiralty were risking too much in putting the Belleville boiler—not that he thought it was dangerous in itself—into every one of the ships of their programme. He had been told that one advantage of these boilers was the easy manner in which they could be repaired. But that was really a trifling advantage, as they were constantly getting out of order, and it would be far better and cheaper at the outset to put in a boiler that did not want such frequent attention. He hoped that the Admiralty would not too rashly make an experiment with these boilers on a scale so large as to mean ruin to the efficiency of the naval programme.

Sir E. Reed replied that the honorable member who last spoke actually stated to the Committee more than once that he did not know what was the value of water-tube boilers as compared with the ordinary cylindrical boilers. There were, he thought, good reasons for the adoption of water-tube boilers. An ordinary double-ended cylindrical boiler would contain from 30 to 35 tons of water, and was ready to explode with terrible violence in the event of any disturbance from outside. Water-tube boilers, on the other hand, would not contain more than a tenth of that quantity of water. Surely that was an intelligible object to accomplish in a ship subjected to the blows of torpedoes and of guns. Then experience and science pointed to the necessity for increased pressure if they were to have greater economy. They had, however, gone as far as they could go with regard to pressure in the case of the cylindrical boiler, but in the case of the tubular boiler they could resort to a much higher pressure. Still, he must say he was a little startled on reading the passage in the First Lord's statement that "it is proposed to adopt boilers of the water-tube type in the new ships to be laid down in 1895–96." That meant that the cylindrical boiler had already been laid aside in favor of a boiler of which they had not had very much experience. The honorable member for Gateshead, with a forcibleness of delivery which would make a man believe almost anything (laughter), had spoken as if boiler accidents were unknown prior to the introduction of the tubular boiler. But there had been many cruel explosions with cylindrical boilers, both in and out of her Majesty's Navy. Then it had been represented as a terrible thing that the tubes should wear out so fast. He admitted that if that was permanent, it would be objectionable, although he did not think that the more rapid destruction of the tubes than of cylindrical boilers would of itself be a reason for giving them up. If they obtained advantages in other directions, they should be prepared to renew the tubes more frequently. He did not wish to express any strong or decisive opinion on the matter, but he believed the government could not have avoided making a considerable and extended introduction of these boilers in the Navy. There might be difficulties, and even accidents, but they must make their tubes as they made everything else—competent for the work they had to perform.

Mr. W. Allan: "Why did the tubes burst in her Majesty's ship *Sturgeon?*"

Sir E. Reed: "I have not the smallest doubt that the tube burst because it was unable to bear the pressure."

Mr. W. Allan said the tube was tested at 1,000 lbs. per square foot, and afterward at 290 lbs. The pressure at which the boiler worked was 200 lbs., and it did not register that pressure when the tube burst almost from end to end and the fatal disaster occurred.

Sir E. Reed remarked that it was a common thing for a tube which had stood a very high hydraulic test to give way under heat. His contention was that if one had a good object to accomplish one must not try to carry it out by insufficient means.

This discussion resulted in calling out a number of communications from prominent English engineers and others, which are very interesting, but which we are compelled to condense.

Mr. Walter H. Maudslay, Chairman and Managing Director Maudslay Sons & Field (Limited), writes to *The Times*, and after saying that his firm are the sole manufacturers of the Belleville boilers in England, he adds politely that Mr. Allan did not know what he was talking about when he made the remarks which are given above, and that he did not take the trouble to inform himself. He—Mr. Maudslay—then went on to say that Mr. Allan has hopelessly jumbled up the Belleville with all other boilers, and, continuing, said:

"Now, roughly speaking, about 60 ships have been fitted with these water-tube boilers, driving engines of a total power of 350,000 horses, and in no case have we ever heard of an accident of any sort; and yet Mr. Allan speaks of the Admiralty as using untried boilers of a most dangerous character, and states that dreadful accidents have taken place with them. . . .

"All the new ships in the French Navy are boilered with water-tube boilers, most of them being of the Belleville type. I give here the names of some of their most important vessels fitted with Belleville boilers: *Bouvet*, 14,000 I.H.P.; *Descartes*, 8,500 I.H.P.; *Pascal*, 8,500 I.H.P.; *Pothuau*, 10,000 I.H.P.; *Galilée*, 6,600 I.H.P.; *Catinat*, 6,600 I.H.P.; *Bugeaud*, 9,000 I.H.P.; *Chanzy*, 8,500 I.H.P.; *Charner*, 8,500 I.H.P.; *Latouche Tréville*, 8,500 I.H.P.; *Brennus*, 14,000 I.H.P.; *Lavoisier*, 14,000 I.H.P.; *Charlemagne*, 14,000 I.H.P.

"The Russian Government have during some years past fitted most of their important vessels with Belleville boilers. For instance the new *Rurik*s and the *Standard* (the new yacht for his Imperial Majesty the Tsar), of 14,000 I.H.P., are among the latest.

"As to our own experience. About two years ago my company fitted with machinery and Belleville boilers the warship *Gremyaschy* at St. Petersburg. Although this was our first attempt, we took this vessel out for her official trial without even one of a preliminary character, and we had an unqualified success. Since then this vessel has been in commission, and with her own Russian stokers has beaten our trial trip records, and that without a single hitch.

"The officials of the Volunteer Fleet of Russia have adopted these boilers, and my company are now fitting 25 boilers in the first of the new vessels to be ordered—viz., the *Cherson*, of 12,500 H.P. We shall also soon be trying the *Egyptian Monarch*, Mr. Wilson, of Hull, having intrusted us with the order for Belleville boilers for that vessel, and we have also fitted some other smaller ships.

"We find also that nearly all the foreign governments are contemplating the Belleville boilers for their new vessels. . . .

"The Messageries Maritimes have all their vessels fitted with these water-tube boilers, and are continuing to order them. . . .

"The truth of the whole matter is this, we must have higher speeds and higher pressures of steam. The old cylindrical boiler has come to the end of its tether. It was all very well with steam up to a certain pressure, but its very construction made it rebel against more exacting requirements. No matter who made the boilers, or how carefully they were made, when driven too hard they began to leak, and nothing could satisfactorily stop them. With Belleville and other water-tube boilers it is possible to have steam of any pressure. They have no rigidity and do not leak. Using a reducing valve, the steam can always be kept up to a higher pressure in the boiler-room than in the engine room, so that if the stoking does for a time fall off the revolutions of the engine keep the same, owing to there always being a *plus* pressure in hand.

"Water-tube boilers are easily repaired. A Belleville boiler can be readily taken up or down any hatch without disturbing the vessel; there is no necessity to drag up the decks to remove a boiler, as is the case with cylindrical ones, with all the heavy expense of pulling up deck fittings, etc.

"The boilers can be repaired in an hour or so, are inexplosible, and if one were damaged during an engagement, it could easily be repaired without putting the vessel out of action, as would be the case with a cylindrical boiler.

"Then, again, if cylindrical are matched against Belleville boilers, fully one-third of the weight is saved by the latter. But the most important feature of all is, perhaps, the rapidity of getting up steam. An ironclad with cylindrical boilers would take from 12 to 18 hours to get steam up; the same vessel with Belleville boilers would have a full head of steam in three-quarters of an hour. Surely this is an all-important feature in time of war.

"With regard to the various types of water-tube boilers of a lighter character, which must not be confused with Belleville boilers, we are all feeling our way. My own company is fitting four vessels of the 27-knot class, which is the speed the Admiralty ask for the torpedo-catchers now building—the new ones, I believe, are to go several knots faster—an enormous advance. With no boilers can this be done unless they are of the water-tube type, as weight down to ounces must be considered."

To this Mr. Allan responded that if the Engineer-in-Chief at the Admiralty thinks he has sufficient *data* to warrant him to go in for such a wholesale adoption of water tube boilers for vessels building and to be built, he (Mr. Allan) does not, and many others think likewise.

The whole drift of his speech, he says, was that these boilers ought to be subjected to a fair, ocean-going, full-speed test, over an extended period and for long distances—say, in a second-class cruiser—so that all the engineering points involved in working could be ascertained correctly and reported upon by unbiased experts on board, prior to any extended adoption of them, as contemplated in our fleet.

Mr. John I. Thornycroft also "rose to explain," and, in a letter, said:

"Two statements have been made prejudicial to the interests of my firm, and I would therefore beg for the insertion of a few lines.

"Mr. Allan has stated that it is not possible to obtain economy in coal consumption in vessels fitted with water-tube boilers. . . . I enclose a table showing the results obtained in her Majesty's ship *Speedy* with water-tube boilers bearing my name. This table not only proves that water-tubes may be economical, but it shows that this particular form of water-tube boiler is capable of yielding results superior to the best of those given by Mr. Durston in his recent paper read before the Institution of Civil Engineers. The *Royal Sovereign*, which is the most economical ship quoted by him, consumes, under natural draft, 1.84 lbs. of coal per I.H.P. per hour, while the *Speedy*, under very similar conditions, consumed only 1.58 lbs. per I.H.P. on a trial of 20 hours' duration. This amply proves that the highest economy is possible with the *Speedy* type of boiler. This boiler has also the advantage of being remarkably light, although adapted for a high steam pressure. Again referring to Mr. Durston's paper, where details of the machinery of vessels of the *Speedy* class are given—and it must be remembered that in these vessels particular attention has been paid to reduction of weight—it will be seen that the I.H.P. developed per ton weight of boiler averages in the case of the locomotive type 29.5. In the Belleville, as fitted in the *Sharpshooter*, it is 26.1, while in the *Speedy* it is 43.9. It will be seen that the French boiler is compared to some disadvantage, as the locomotive is the lightest of internally fired boilers, for in the *Royal Sovereign*, which has cylindrical boilers, the I.H.P. per ton is only 22.3. This shows that boilers of the latter type require to be twice the weight of those of the *Speedy* type for a given power.

"Mr. Maudslay says that 'with regard to the various types of water-tube boilers of a lighter character, which must not be confused with the Belleville boilers, we are all feeling our way.'

"However true this may be as regards Mr. Maudslay's own attitude, I cannot accept this description as correctly applying to my firm, for the boilers we are fitting in destroyers are of a well-tried design."

A correspondent who signs himself "Navalis" "goes for" Mr. Maudslay, who the correspondent says,

"Brings forward, as examples of success, a list of 13 ships of the French Navy as 'fitted with Belleville boilers.'

"Omitting a clerical error, by which he describes the *Lavoisier*, an unfinished third class cruiser, as having engines of 14,000 H.P., there remain 12 war vessels, none of which have as yet completed a satisfactory and final trial, and about half of the 12 are still in embryo."

Messrs. Yarrow & Co are also heard from, and testify that "from our own experience, and from what has been accomplished in France, we believe there can be no question that water-tube boilers are destined to be largely introduced in the course of time, and the benefits secured are such as to render them specially desirable in the case of war vessels. In some forms the water-tube boiler is much lighter, safer under the high pressures now demanded, more easily repaired (without the necessity of taking to pieces a large portion of the vessel), they require less skill in stoking, admit of raising steam with greater rapidity, and as regards economy of fuel are either on a par or superior to the old forms.

"Although we sometimes differ from Mr. Durston, the Engineer-in Chief of the Navy, on this point we do not. We believe, as we have often stated in public, that the action of the Admiralty in selecting water-tube boilers—undoubtedly a very bold step—will be recognized in the future as correct, and later on the wisdom of the course adopted by the authorities lending official sanction to one of the most important advances in marine engineering will be fully appreciated. . . .

"We are not speaking from any interested motive, as we make boilers of both classes; but we feel bound to defend a policy which we believe correct, from whatever source it emanates."

Mr. Fortesque Flannery writes:

". . . How far the Admiralty is justified in deciding to fit, not one, but two of the largest cruisers with boilers of this type later events must show; but there is no doubt that if the *Powerful* and the *Terrible* steam satisfactorily with their water-tube boilers they will be the first large vessels under the British flag, either in the royal or mercantile navies, that have done so. The ordinary course of a shipowning company would be to try one vessel of medium size first, under every possible condition of high pressure and full speed, for a period of a few months, and to be guided by results before extending the use of a hitherto untried device. Having regard to the number of comparatively small vessels at present at the disposal of the Admiralty the boilers of which are nearly worn out, it would seem a reasonable course that one of such vessels should have been selected, 'Belleville boilers' put in at an expenditure of time of only a few months, and a thorough test made under the immediate guidance and control of royal naval officers with a ship in commission during at least one voyage at full speed. . . .

"The results, more or less encouraging, of water-tube boilers of different types in the torpedo-catchers throw only a distant light upon the 'Belleville boilers,' as the construction is in many respects substantially different."

Mr. John D. Ellis, Chairman of John Brown & Co. (Limited), in response to what he calls "the public reiteration," that the cylindrical boiler has come to the end of its tether, says:

"At present this statement is not warranted by the actual condition of things.

"The Yarrow, Thornycroft, and kindred boilers may be all that is claimed for them for torpedo-boats and similar vessels, but for large war, passenger, and cargo ships the makers of the Belleville and similar boilers are not likely to find the cylindrical boiler dead, as they apparently wish every one to believe.

"Mr. Allan has spoken of the safety of natural draft and considers 'forced' draft 'unnatural' draft. Certain well-known troubles have, no doubt, been experienced in the application of forced draft to cylindrical Scotch and locomotive boilers with large nests of small plain tubes closely packed, but it does not follow that with large diameter tubes, ample water spaces, ready escape of steam, and strong mechanical

suction draft, which in its action upon the boilers is the same as natural draft, the same difficulties will occur. As a matter of fact there is already nearly four years' experience that with this suction draft it is perfectly safe and convenient to obtain from cylindrical boilers two to three times the amount of the work obtained with natural draft, and from the absence of troubles at these rates of combustion it is clear they may be still further increased. The 'Serve' tube having twice the internal heat-absorbing surface of the plain tube of any given diameter, has, moreover, enabled—even for the highest rates of combustion—the use of large diameter ($3\frac{1}{4}$ in.) tubes with large water and steam spaces. The economy arising from the use of the Serve tubes with retarder is increased by heating the air with the heat of the waste gases, and the result is that these cylindrical boilers, even at three times the ordinary combustion of natural draft, give an evaporation per pound of fuel equal to current practice with natural draft and plain tubes, which shows a considerable economy over that of the ascertained results of the Belleville boiler.

"Even at only twice the combustion of natural draft with ordinary funnel height the cylindrical boilers occupy less floor space than the Belleville boilers for a given I.H.P., and when we come to the weight question the great difference in the coal consumption per I.H.P., moreover, is to the advantage of the cylindrical boilers in all long-voyage vessels, surprising as this may be to some of your readers accustomed to hearing one side only. Mr. Howden wished to make a trial between the Belleville boiler and the cylindrical boiler with his system. Comparative evidence exists already close at hand establishing the great economy of the cylindrical boiler even under less favorable conditions than with his or the still more economical suction draft system referred to above. The London, Brighton & South Coast Railway have two new steamers running between Newhaven and Dieppe. The *Seaford*, built by Messrs. Denny, has cylindrical boilers, ordinary Serve tubes, plain stay tubes, and closed stokehold forced draft, which is the least economical of mechanical drafts, because it does not utilize the waste heat of the gases after they leave the boiler. The sister ship, *La Tamise*, was built in France and fitted with Belleville boilers. They both develop the same I.H.P. and have the same speed, but the *Seaford* averages $27\frac{1}{4}$ tons of coal per trip, and the *Tamise* $37\frac{1}{2}$ tons. Let the owners of long-voyage steamers or of Atlantic racers calculate for themselves what this would mean to them.

"The system of suction draft with cylindrical boilers referred to is working well in Australian and Atlantic steamers—in some at 200 lbs. working pressure with quadruple engines. The Belleville boiler works at 250 lbs. pressure, because it is considered more economical to do so than at a lower pressure, and by means of a reducing valve the steam is supplied to the engines also at 200 lbs. The susceptibility to quick considerable variations in pressure because of the small steam storage is thus counteracted in the Belleville boiler, but the cylindrical boiler with large steam space has no need for this.

"Much is made of the facility of repairs, as if these were expected to form an important feature. If, however, the tubes and furnaces of a cylindrical boiler should require replacing, there is no difficulty whatever in doing so, and even if the Belleville boilers for any given I.H.P. were to last as long as a cylindrical boiler—an assumption which has yet to be demonstrated—I venture to say that the advantage resulting during the life of the boilers from the much smaller weight of coal used and carried will far more than compensate for the extra cost in taking cylindrical boilers out of and putting new ones into the ships.

"Not even the feature that steam can be raised 'in an emergency' in half an hour can be claimed as the special property of the Belleville boiler. The same has been done with perfectly cold cylindrical boilers fitted with this system of draft, without evil consequences, in practically the same time."

To a question proposed by Mr. Wolf in the House of Commons, who asked for information about the boilers of the *Sharpshooter*, Mr. Robertson said: "The *Sharpshooter* was fitted with eight Belleville boilers 12 months ago, and these were first tried on board under steam in February, 1894. Seventeen steam trials were made at various powers and durations up to 30 hours. The ship was commissioned in September, 1894, and while on service with the Channel Squadron has made two special 12-hour trials and the usual quarterly 24-hour trial, and the result as regards the Belleville boilers has in each case been most satisfactory."

Mr. C. Johnstone, among other things, says:

"As a sea officer I am looking at the matter only as it concerns the public interests represented by the Navy, and I believe the introduction of these boilers to be a step as advantageous as it is important. . . .

"I will not attempt to argue this question as presented by theoretical engineers. I look at it from the man-of-war's man's point of view, and consider that if these boilers will stand wear and give the required speed we may make the advocates of cylindrical boilers a present of all the advantages they claim. Are the water-tube boilers, taken generally, more expensive of coal? do they occupy more space? Be it so, we will accept that; but what we want in the Navy is boilers which:

"1. Will raise steam quickly.

"2. Can be renewed without pulling important parts of the ship to pieces.

"3. Will not suffer much from small projectiles.

"4. Will not explode with most disastrous effects.

"All these needs, I understand, the water-tube boiler supplies. This has not reference to any particular make—to this boiler or that boiler—but to the type of boiler which contains its water in small spaces." . . .

Another correspondent, who signs himself "M.," criticises Mr. Maudslay's statements as follows:

"The worthlessness of Mr. Maudslay's list of French warships fitted with Belleville boilers as proofs of actual performance has been pointed out. The fact is that the working experience in that Navy is limited to the *Alger* and a very few low-powered and comparatively unimportant vessels, and proved too slender to enable the authorities to make a success of the trials of the *Brennus*. These trials have been criticised, and Mr. Maudslay has not averred that the ship realized her legend power of 14,000 H.P., although her boilers occupy an enormously larger space than those of the *Sans Pareil*, which exceeded that power on trial. The space occupied by the boilers of the *Charlemagne* is 50 per cent. greater than that allowed in our new battleships. And the fact remains that in the new cruiser *D'Entrecasteaux* cylindrical boilers are to be installed.

"Mr. Maudslay's references to the Russian Navy are just as worthless. The Russian Government has not, as he says, 'during some years past fitted most of their important vessels with Belleville boilers.' The three ships of the *Sinope* class, the three of the *Poltava* class, and the *Georgi Pobiedonosetz*, *Tri Sviatitelia* and *Dvenadsat Apostolov* are all important vessels, and they all have cylindrical boilers; so are several others. The ships that have the Belleville boilers are the old cruiser *Minin*, two or three yachts of small power, and the three vessels of the *Gremiastchy* class. The latter warships are described in the *Naval Annual* as armored gunboats of 1,500 tons displacement and 2,000 H.P., no criterion whatever for powers 12 times as great.

"Mr. Maudslay contends that the Belleville boiler is necessary if higher pressures are to be used; that the cylindrical boiler leaks, and has got to the end of its tether. The fact remains that cylindrical boilers, in the mercantile marine, as large as 16 ft. in diameter are used for pressures of 200 lbs. per square inch, and are worked both under natural and forced draft without leakage. If the Admiralty cannot go beyond their present standard of 155 lbs. pressure without leakage it is the fault of the designers of the boiler, who persistently refuse to take a hint from mercantile boilers built for forced draft. And in any case the Belleville does not supply steam at 200 lbs. pressure to the engines in any ship to which it has been fitted.

"Mr. Maudslay says that all the Messageries Maritimes Company's steamers are fitted with Belleville boilers; the fact is that seven out of a total of 57 are so fitted. Four of these form the line to Australia, upon which the superiority of the boiler is held to have been proved. Now the two fastest P. & O. steamers—*Australia* and *Himalaya*—frequently run from Brindisi to Adelaide at speeds of 16 to $16\frac{1}{2}$ knots, and the latter has run from Bombay to Brindisi at about 17 knots (excluding Canal). They have practically the same engines as the Messageries Company's boats, and cylindrical boilers with 500 sq. ft. of fire-grate, while the least powerful of the French boats has 624 sq. ft. Although the latter are much longer and finer ships, they do not maintain any such speeds, the average of the round voyage being under 15 knots; not that they cannot steam faster on a pinch, but presumably the coal consumption is so utterly ruinous when the ships are driven that it is not attempted. These matters have been fully dealt with elsewhere, and Mr. Maudslay made no attempt to traverse the criticisms levelled at the boiler. The Messageries Company, with the strongest possible inducements to run their boats at the highest practicable speed, run them at one altogether incommensurate with their great length, fineness of form, power and quality of their engines, and extent of their boiler installation; and an engineer accustomed to mercantile marine

procedure would have seen the fallacy of the thing directly. From Mr. Robertson's argument it would appear that M. Gaudin was sent to judge by what he was told, not by what he saw.

"The Belleville boiler has been tried in the United States by an engineer who is described in Mr. Maudslay's advertisements as having had years' experience with it, and knowing more about it than any one in America. In fitting it to a large, fast Lake steamer of the same power of engine as the Messageries boats this experienced engineer increased the number of boilers from 20 to 28, and the grate and heating surfaces by 30 per cent.; but the current issue of the *Engineer* states that she has so far failed that the order for a similar set of boilers for a sister ship has been suspended. In the mean time, a large Atlantic liner, with practically identical engines, and cylindrical boilers working under forced draft, and supplying steam at 200 lbs pressure, is working most successfully, her boilers occupying just half the floor space of the Belleville boilers in the Lake steamer.

"To sum up: The Admiralty decided on Belleville boilers for the *Powerful* before they had acquired any experimental information of their own as to their capabilities, and the subsequent trials of the *Sharpshooter* have thrown no additional light on the matter. The performances of the *Alger* have not enabled the French naval authorities to make successes of the trials of the *Brennus* and *Latouche-Tréville*, as far as they have gone. It has not been found practicable to work the Messageries Company's boats continuously at a higher than 5,000 H.P., and an American engineer of experience, who added largely to their boiler capacity to develop their trial powers in ordinary working, has not succeeded in attaining his desires. The engineer sent to investigate the working of the boilers in the Messageries boats was devoid of the experience which would fit him to make a report of any value on their behavior as compared with cylindrical boilers under similar conditions, and yet the Admiralty persist in taking a leap in the dark, not only in these two ships, which are of vital importance to the safety of the nation's commerce, but in other ships to be laid down. Nothing more unjustifiable has ever been attempted since we have had a steam Navy."

This discussion will probably interest engineers in this country as much as it does those on the other side of the Atlantic, which must be our excuse for devoting so much space to it.

YARD ARRANGEMENTS ALONG HEAVY-TRAFFIC HIGH SPEED RAILROADS.*

By A. Flamache.

(*Concluded from page* 180.)

JUNCTION STATIONS.

These are stations where more than one line enters, and where there is sometimes a considerable amount of transferring of passengers and freight. These stations have important local installations, and the entrance of trains for side-tracking or switching is always made head on.

The service of junction stations, viewed from the standpoint of the main line, includes:

1. The passage of through trains.
2. The entrance and exit of local passenger trains running over both the main line and the branches.
3. The side-tracking of slow trains.
4. The entrance and exit of freight trains.
5. The switching and handling of freight trains.
6. The service of the freight yard and factory sidings.

The Entrance and Exit of Local Passenger Trains.—This portion of the service necessitates certain arrangements, the forms of which may differ greatly. In our opinion the best disposition that can be made of the tracks is that shown in fig. 34.

If the branches are situated in the same manner relatively to the main line, there is nothing to prevent their reuniting in a single common trunk (as is actually done, except in the case of an important track), and then to divide the arriving and departing tracks into a certain number of tracks that run in alongside the platforms.

The number and arrangement of the local tracks depend upon the special service of the station. Some local tracks can be used for both arriving and departing trains. Furthermore, it is sometimes possible to permit, without involving any serious hindrance to the service, that local trains running over the main line can stop on the main tracks that run alongside platforms built for this purpose. There are other reasons that may permit of the reduction of the number of local tracks that can be examined for each individual case.

* Bulletin de la Commission Internationale du Congrès des Chemins de fer.

The network of local tracks will connect at one end of the station or yard with the main tracks in such a manner that it is possible for trains to run in from the branches to the main line as well as in the opposite direction. Finally, in order that the track A may not be unnecessarily crossed by the trains running along track B, it is well to construct a special siding for B, along which platforms should be built for the accommodation of local trains running on B, as shown in fig. 34. The side-tracking of trains on A is done on the local tracks, and merely

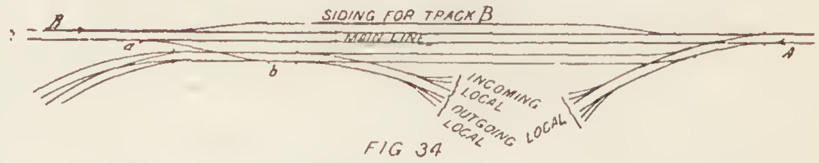


FIG 34

FIG. 35

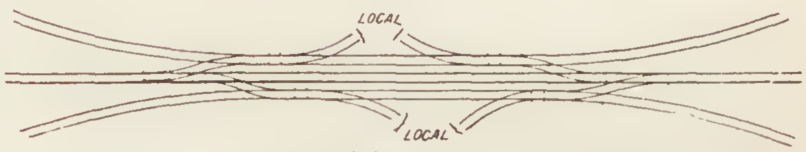


FIG 36.

calls for the addition of an exit switch $a\,b$. If the branches approach the main line from different directions, but are still upon the same side of it, the preceding arrangement, as shown in fig. 34, is doubled, as in fig. 35. The same thing occurs if there are branch lines debouching from both sides of the main line; but it will readily be seen that a greater complication is involved.

When some of the branches are single track, they are brought together by the common method shown in fig. 37. The first is especially applicable when the single-track branch turns off to the right. The second is shown, in this case, with the two connections made by means of a cross-over. It is, nevertheless, to be recommended when the single-track branch leads off to the left.

FIG. 37.

FIG. 38.

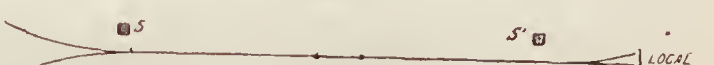


FIG 39

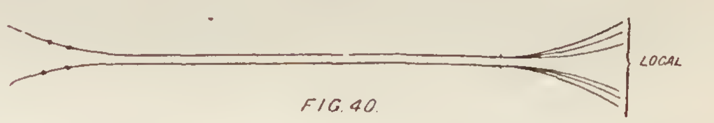


FIG. 40.

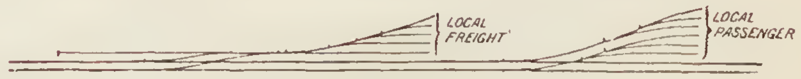


FIG. 41.

When all the branches of the same section are single-track, there is an advantage in not bringing them together before running into the station. The arrangement shown in fig. 38 requires a great deal of special apparatus, and is not favorable to the service, at least, if it be the single-cabin S and not the station G that controls the single-track blocking on the two trunks. The arrangement given in fig. 39 is dangerous, unless there is established a single-track block between the cabins S and S', independently of the simple single-track block. Under all conditions the arrangement of fig. 40 which carries each branch up to the starting-point of the local spurs, is the best.

It should be possible to use the local tracks for freight as well as passenger trains, but there is no reason why special tracks should not be reserved for the former. It is nevertheless necessary that the lay-out should be in good shape. The arrangement in use at the Belgian stations, which separates the local passenger service from that of the freight, offers

especial facilities to the local traffic, but has serious disadvantages when viewed from the standpoint of the main line, as shown in fig. 41. A greater total number of signals in connection with the main line, double the number of point switches and cross-overs, an uninterrupted succession of signals necessitated by this apparatus, creating confusion in the minds of the drivers of fast trains, are some of the main defects of this arrangement from the standpoint of the passage of high-speed trains.

The connection of the local freight service, by means of a

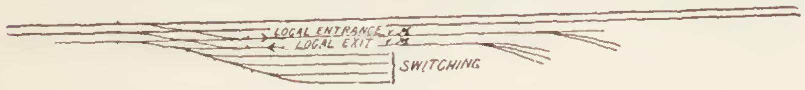


FIG 42

FIG. 43


FIG 44

FIG 45

twofold change of track placed on a blind siding, causes a very serious delay to freight trains. The impossibility of stopping the switching work at the scheduled time for the arrival of these trains, their time being only approximate, it follows that the freight trains are often stopped at the entrance to the yard, where they obstruct the main lines, while waiting for the switching work to be completed and the sidings to be cleared. The main line thus remains blocked during the whole of this time.

of necessity, especially where the local switching work is of little importance. The arrangement shown in fig. 42, in which the special tracks are reserved for the entrance and exit on the one hand, and for the switching on the other, of freight trains, amply fulfils the conditions laid down above. It will be noted that the entrance and exit tracks are in the same position as the switching tracks, when viewed from the standpoint of the general service. The local service of this arrangement presupposes the common use of the same track by both passenger and freight trains, but there is no reason why it should not be doubled, as in fig. 43.

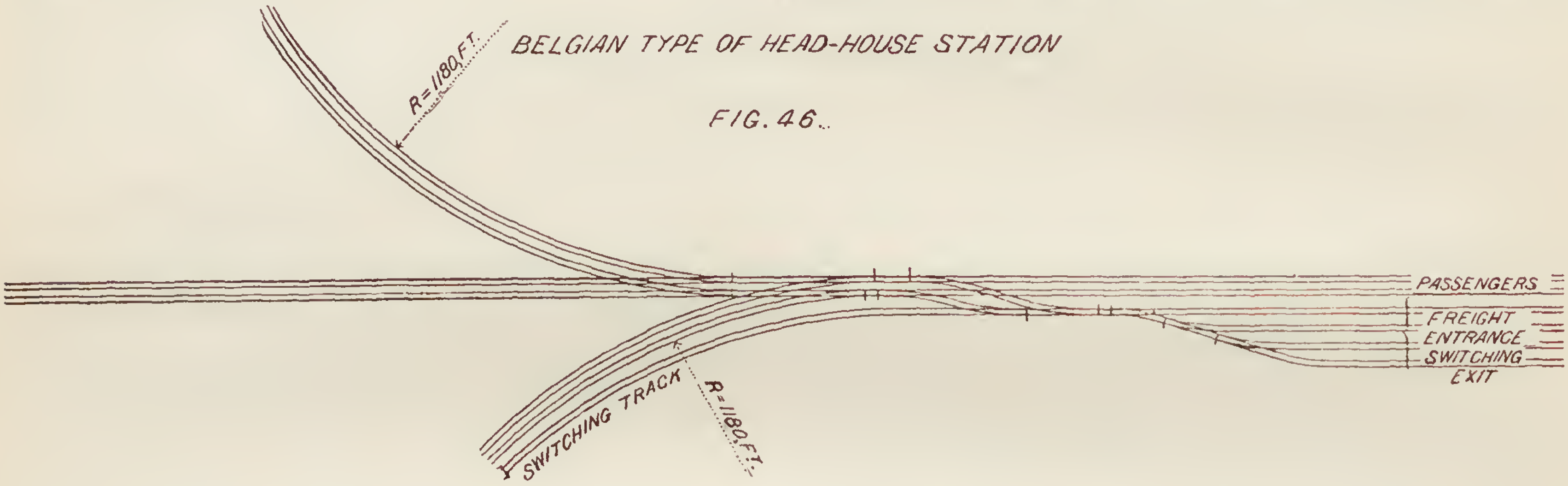
The advantages of the preceding arrangements are at once apparent; the distance between the extreme switches is reduced to a minimum; it is equal to the greatest length of trains which run over the line increased by the length of the connections at the end; the local tracks and the switching tracks are separate—that is to say, switching movements can be freely carried on while trains are running in and out. The latter are, therefore, never kept standing on the main lines.

This arrangement can be criticised from the fact that it does not permit a train to enter or leave either one of the switching tracks at will. In point of actual practice there is no real foundation for this criticism. It is necessary to leave some of the tracks of the switching spurs free for the entrance and exit of trains; the last movement will consist of backing a train out upon the exit track. It is evidently necessary that this *cul-de-sac* should be long enough, so that it will not be necessary to allow a train to stand or to do any switching upon the main lines.

It is furthermore possible to design mixed arrangements, of which figs 44 and 45 are examples, which possess certain facilities. There is nothing to prevent the method of connection shown in fig. 41 being adhered to in the case of branches of minor importance. Fig. 47 illustrates a station of the head-house type, laid out so that the rights of the main line shall be respected, while the branches are treated in accordance with the actual requirements of the individual case. The entrance and exit of freight trains running over branches that lead in on the opposite side of the main tracks from that on

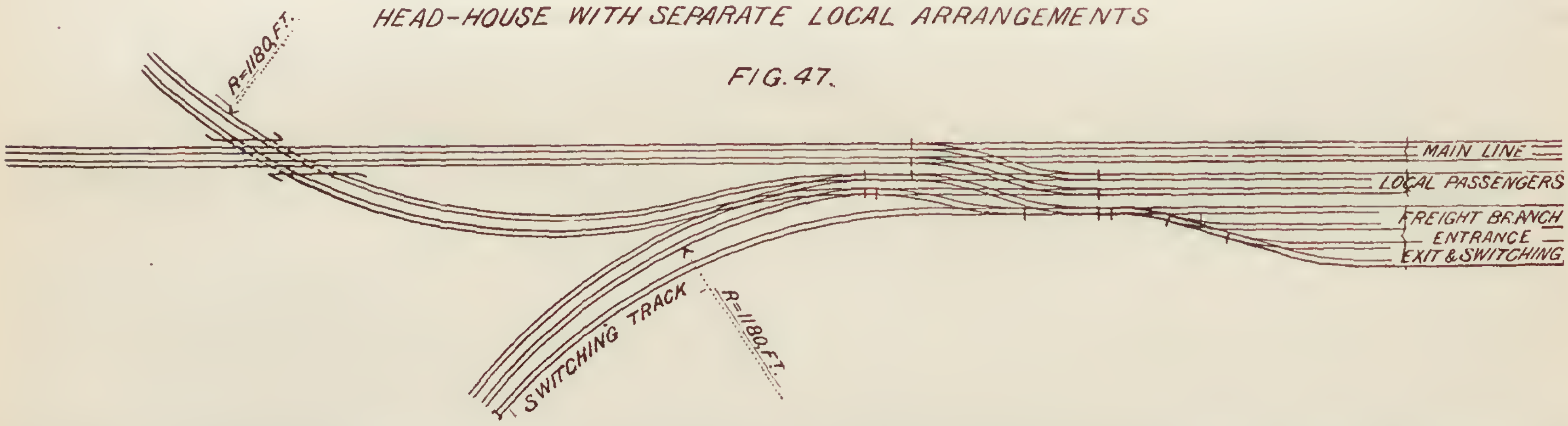
BELGIAN TYPE OF HEAD-HOUSE STATION

FIG. 46.



HEAD-HOUSE WITH SEPARATE LOCAL ARRANGEMENTS

FIG. 47.



Again, the complete interruption of the switching work every time a train enters or leaves the yard will cause serious losses of time to the yard gang. Finally, switches and points that are constantly traversed on a down grade in the switching work, necessitating the constant use of the brake, are rapidly worn out and are impossible to maintain. The result is that derailments are of frequent occurrence, and each one has the effect of obstructing the main line.

The complete separation of the switching tracks from those used for the entrance and exit of the freight trains is a matter

which the local tracks are situated evidently necessitates the crossing of the main line. This can only be avoided by the use of a bridge or under-grade passage, as will be shown later on. Unfortunately this method of track construction is almost always impossible to execute, at least from a financial standpoint, where the changes of important stations that are already built would call for very heavy expenditures. In most cases the engineer is compelled to content himself with joining the branches to the main line by connections that are reduced to those found to be absolutely necessary. It is, of course, evi-

dent that the local passenger service should always be on the same side as that from which the branches lead off, unless this is absolutely impossible. A couple of examples of yards laid out in accordance with these principles are clearly shown in figs. 48 and 49. The switches *p q* serve for the local incoming traffic, while the switches *m n* allow the departing trains to run out on to the branch.

FIG. 48.

FIG. 49.

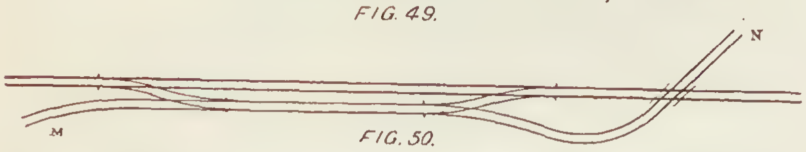


FIG. 50.

The more or less serious difficulty which is involved in connecting the local freight tracks with branches debouching from the opposite side of the main lines, without introducing numerous switches and signals into the service, will evidently oblige us to put the local freight tracks on the same side as that from which the greatest amount of traffic is run out, in order that the main line may be crossed by as small a number of trains as possible; but relative considerations at the yard limits often require the installation of such apparatus. There is a tremendous advantage in carrying all branches from the side on which they must necessarily be started over or under the main line, as shown in fig. 47. This arrangement, though always handicapped by the expense, should be carefully considered. It possesses especial advantages when certain trains are to be run direct from *M* to *N*, or *vice versa*, especially when these trains are slow ones (fig. 50).

I even think that in case of the impossibility, either financial or otherwise, of constructing an overhead or underground passage, that it would be advantageous, from the standpoint of the main line service, to carry the branches across at grade from the side on which the local tracks are situated, well in advance of these later, and consequently away from the switching and yard work. A complete cross-over, laid down with especial care, and protected by a good system of signals, seems to me to present fewer dangers than a direct entrance into the station.

Freight Yards.—As we have said at the beginning, little attention will be paid, in this paper, to local tracks where their arrangement has no effect upon the main line. The outline of the arrangements for loading, etc., in the diagrams that follow are of no interest, then, beyond their actual connection with the main lines.

In the majority of lay-outs the freight yards and local tracks are connected directly to the main lines upon which they stop for local loading and handling. This arrangement conforms to the spirit of this work where the main line is considered as the principal artery of the local service, but is bad, when viewed from our standpoint, and should be replaced by some other in which the main line is reserved for the exclusive use of high-speed trains that pass without stopping.

The freight yard should, therefore, be connected to the local tracks on its own side, and the necessary connections be further established between these local tracks, so that the trains which

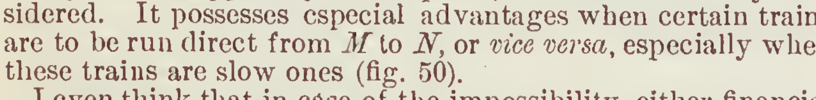


FIG. 51.

are occupying them can drop or take on cars and do such other switching work as may be necessary. When the freight yard is on the same side as the slow freight, the connection is easily made (fig. 51).

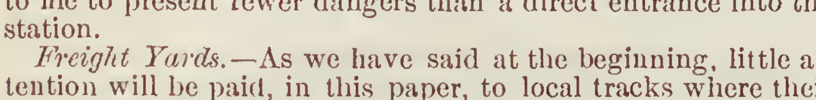


FIG. 52

Two local tracks, *A'* and *B'*, which are devoted to this service are connected with the freight yard in the usual manner, and it is upon these tracks that the trains must stop, leaving the main line perfectly free. When the freight yard is upon the opposite side of the local system for slow trains, it can be connected with the local passenger traffic, if there is one on that side, or with a doubling up of the main-line tracks (fig. 50).

A train running over the main line *B* enters the double siding *B'*, and does its work there without in any way hindering, by its presence, the work on the main line. It is also well to locate a blind siding at *c* which has sufficient length, so that the switching work can be carried on without trespassing upon the exit connection *r s*.

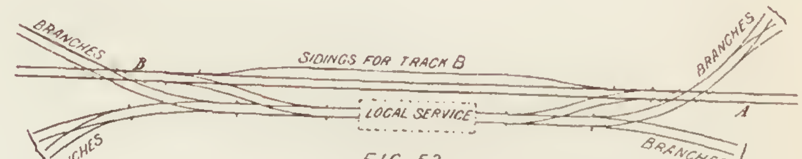


FIG. 53.

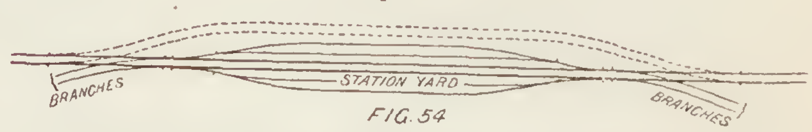


FIG. 54

FIG. 55

On the part of the main line *A* a train enters the local track *A'*, and can then switch its cars over into the freight yard by using the cross-over *M N*. If a train that is occupying *A'* has to be broken up or the cars rearranged, it is best to perform these secondary manœuvres on the switching tracks rather than in the yard proper. It will be noticed that the two tracks of the main line must be crossed each time that any transfer is made from *A'* to the yard. This last movement, which would otherwise be necessarily repeated, should only be made once.

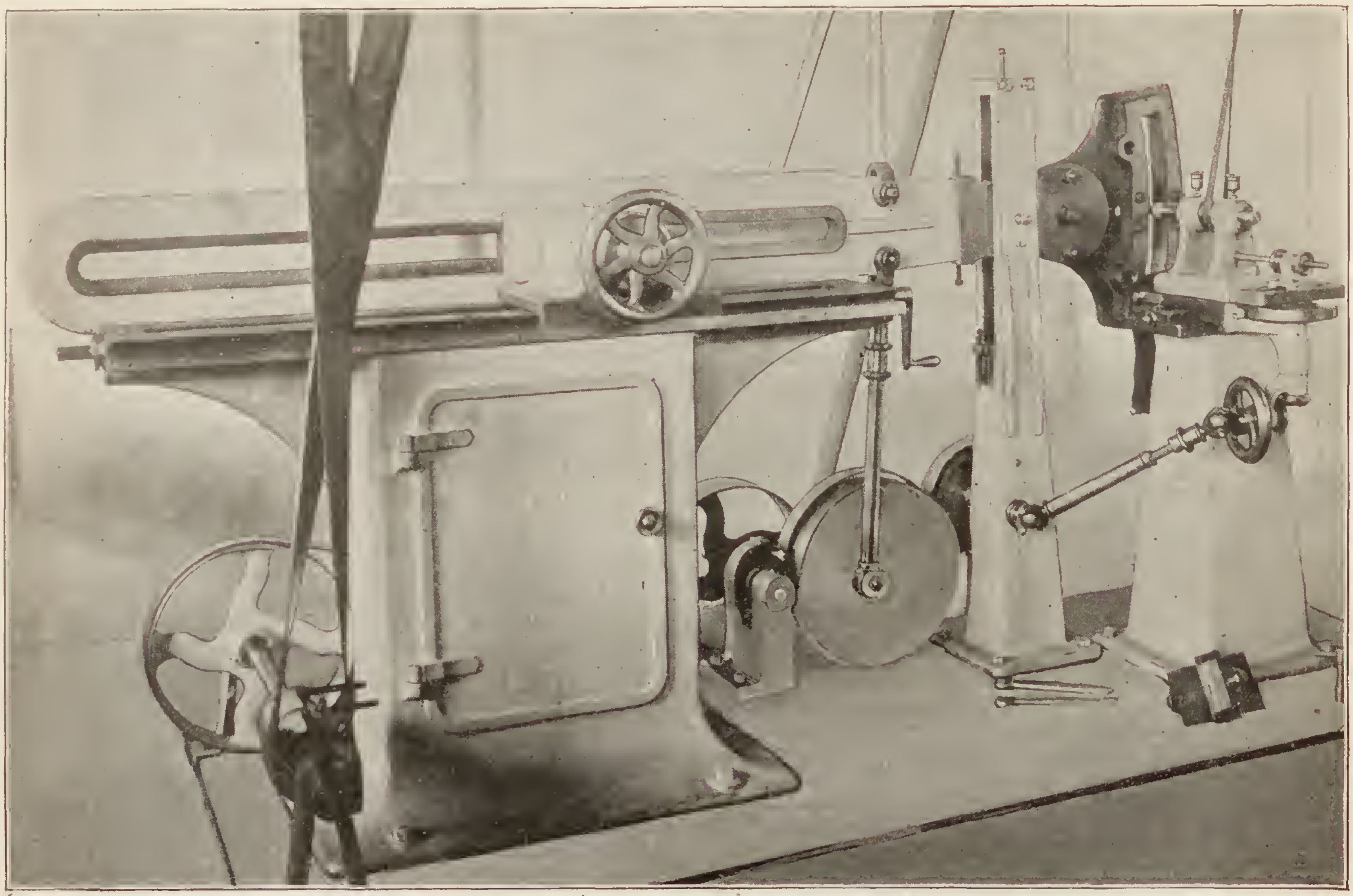
The location of the freight yard on the same side as the local tracks for slow trains has some advantages from the standpoint of the main-line traffic, but this method of grouping is almost always practically impossible, because the switching tracks are, for the most part, generally placed on the opposite side from the most thickly settled part on account of the cost of land, while the loading tracks and freight sheds are more conveniently placed on that side in order to avoid unnecessarily crossing the tracks by trucks and drays which are used for hauling freight to and fro from the depot.

Engine Service.—If trains are compelled to change engines, or the latter are to take on water or coal, it should be so arranged that they can stand upon the local tracks while this is being done. Consequently this work with or for the locomotives has no special interest from the main-line traffic standpoint. In conformity with what has already been said, great latitude should be permitted the station and traction service in these particulars, with the important restriction that they shall keep well off from the main lines. In this respect it is not advisable to imitate the arrangements very commonly used in the Belgian stations, which places the roundhouse and the engine yard on the opposite side, relatively to the main line, from the point where the locomotives are used.

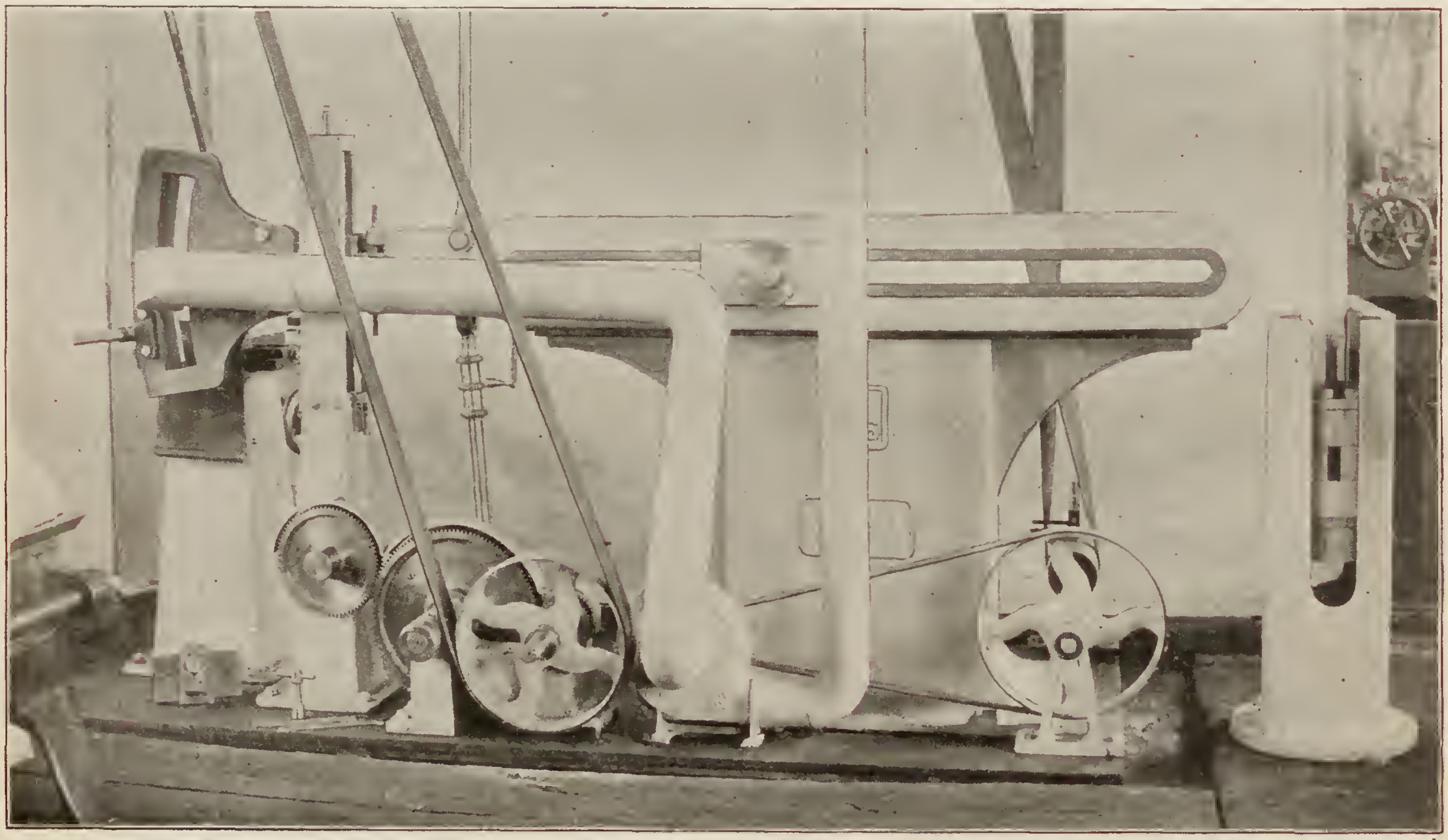
SUPERHEATED STEAM IN ELECTRIC-LIGHT STATIONS.

The difficulties caused by the condensation of steam in steam-pipes and in cylinders are, of course, not by any means new, but the conditions of the public supply of electricity render it especially desirable to procure steam in as dry a condition as possible at the engines. Professor Unwin called attention to the Determination of the Dryness of Steam, in a paper recently read before the Institution of Mechanical Engineers, and described several methods of testing the dryness factor. The conditions of work in an electric-light station are, of course, peculiar. The output of energy is very far from regular. In the winter a sudden fog may call for a supply during the daytime equal to the maximum output usually needed in the evening. In order to meet this demand some of the boilers must always be kept with fires lighted, so that steam may be got up in a few minutes, while it is impossible to avoid putting an extra load upon some of them during a period of great demand.

We know of no type of boiler which will give off dry steam when worked up to its maximum output, for it is certain that the harder a boiler is worked the greater is the chance of water being entrained by the steam. Great trouble had been



FRONT VIEW.

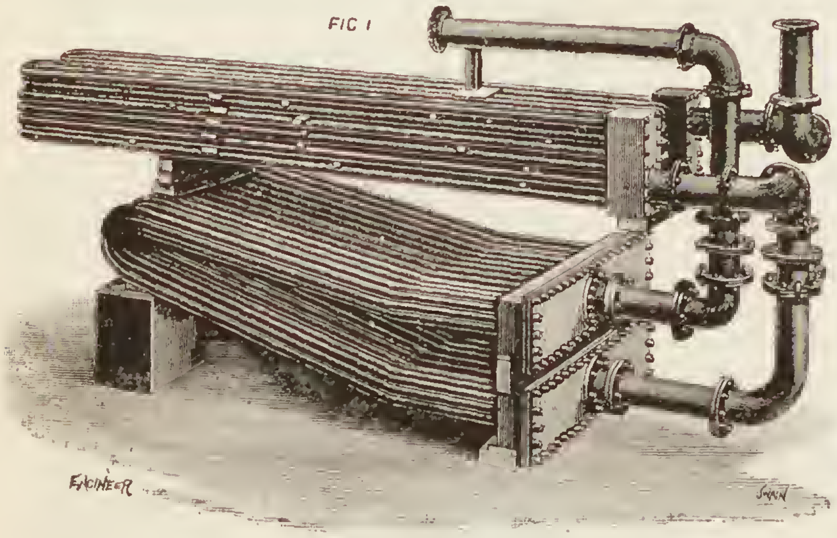


REAR VIEW.

LINK GRINDING MACHINE, GRAND TRUNK RAILWAY.

caused by wet steam at the electric-light station in Maiden-lane of the Charing Cross & Strand Electricity Supply Corporation, Limited, and Mr. W. H. Patchell, the Chief Engineer, found himself obliged to have recourse to some method for drying the steam. In this station the steam-generating plant consists of seven Babcock & Wilcox boilers, six of the size known as 160 H.P., and containing nine of 14 tubes. Five of the boilers are in use at once during the period of heaviest load, and when they were pressed the steam delivered to the engines was found to be very wet.

Two of these boilers have now been fitted with McPhail & Simpson's dry steam generators. The first boiler was altered in 1893—and this was, we believe, the first Babcock & Wilcox boiler which had been dealt with by the inventors—and the second one was fitted up last year.



McPHAIL & SIMPSON'S SUPERHEATER.

Fig. 1 represents the apparatus erected complete before being fitted into the boiler, and fig. 2 shows to a smaller scale the arrangement of the apparatus inside the boiler.

In the Babcock & Wilcox boiler steam is collected from the cylindrical steam vessel by an anti-priming pipe, and taken direct to the steam-pipe; but with McPhail & Simpson's arrangement the steam is collected by a similar horizontal perforated galvanized-iron pipe fixed at the top of the steam chamber; it descends in a cast-iron pipe to a strong closed box which is let into the vertical brick bridge above the water tubes. A number of bent tubes are carried in a group through the hottest part of the flame chamber, and return to a second box placed below the first. The steam is therefore intensely superheated as it passes through this set of tubes, and is taken from the bottom box and carried through a second series of tubes in the water contained in the cylinder. The extra heat is there given up by the tubes to the water, and the steam passes out at the stop-valve still superheated and of course perfectly dry.

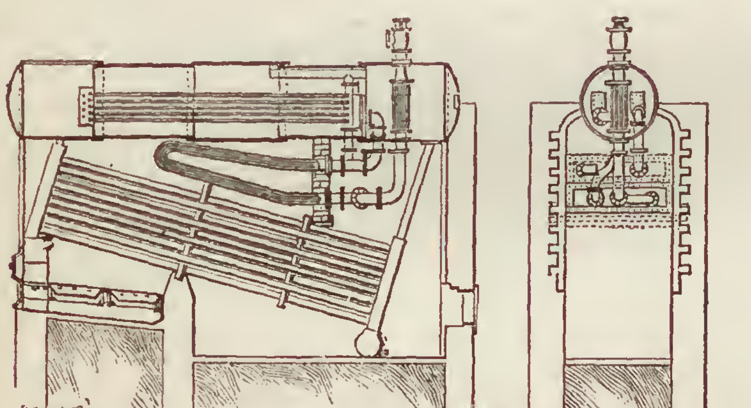


FIG. 2

McPHAIL & SIMPSON'S SUPERHEATER ON A BABCOCK & WILCOX BOILER.

The boxes into which the tubes are fitted are made of cast steel, and the tubes in the fire spaces are specially mild steel 1 in. diameter internally, where they are, of course, exposed to the pressure of the steam, but 2 in. diameter in the water space, where the internal pressure is balanced by the external pressure. Each tube is skimmed up true at the ends by machinery, and is expanded into the boxes.

A slight change from fig. 1 has been made in the method of fixing the pipes at the Maiden-lane station. In fig. 1 the steam would pass four times along the length of the upper cylinder; this was considered unnecessary. The centre loops were, therefore, suppressed, and the ends of the tubes at the left of the figure were joined together by a flanged box, so that the steam now passes twice the length of the cylinder. In this way greater facility was obtained for fixing the apparatus. While the boiler is supplying steam there is, of course, a rapid circulation of steam through the tubes of the apparatus, but the moment the stop-valve is closed the contents of the pipes become quiescent, and it would appear that at such a period the tubes in the fire space must be exposed to excessive heating and may become red-hot. We understand, however, that no practical difficulty has been experienced, and we presume that by regulation of the dampers excessive heating can be avoided.

Photographs have been taken which illustrate the appearance of saturated and dry steam. When the photograph was taken steam was issuing from two ½-in. pipes, which were both conveying steam from a Lancashire boiler fitted with the apparatus we have described, and working at 46 lbs. gauge pressure. The steam issuing from a pipe leading from the stop-valve was almost invisible, showing the improved quality of the steam as compared with that issuing from the ordinary saturated steam space of the boiler. The temperature of the saturated steam was 293° F., and that of the dry steam 392° F. Both the dry and saturated steam were at the same pressure.

The working pressure on the boilers at Maiden-lane is 150 lbs. per square inch, and the area of the stop-valve upon the drum is less than the combined area of the group of pipes.

The following table will show clearly the results obtained from actual tests. Column A shows the absolute pressure of the steam in pounds per square inch at the boiler—that is to say, the gauge pressure plus 15 lbs.; column B, the calculated temperature in degrees Fahrenheit, due to the pressure of saturated steam; column C, the temperature found by experiment at the engine side of the stop-valve boiler and close to it; column D, the rise or fall of temperature obtained:

A.	B.	C.	D.	Remarks.
Lbs.	Deg.	Deg.	Deg.	
166......... ...	366.5	359	7.5	Superheaters not in use.
168....	367.0	361	6.0	" " "
157........	362.0	371	9.0	Superheaters in use.
162.....	364 5	375	10.5	" " "
162.....	364.5	373	8.5	" " "

The temperature in the bottom bend connected to the small tubes in the heating space was measured with a mercury thermometer, and was found as high as 620° F. A considerable part of this heat is, however, given up to the water in the steam drum before the superheated steam passes away by the stop-valve. Mr. Patchell finds that for a period of about one hour during the time of maximum load he can get 50 per cent. more power out of the boilers fitted with this type of superheater than from those which are not yet fitted. We may add that the steam-pipes from the boilers to the engines are thoroughly well coated with fossil meal. Bye passes are now arranged so that the pipes can be filled with steam and so heated up before the main valves are opened. The condensed steam is collected by means of Royle's & McDougall traps, and a Willans steam separator is in use for each of the Willans engines.

The actual economy in coal consumption effected by using two superheaters only in a range of seven boilers is 5 per cent. over a period of 12 months. We are informed that two more superheaters of the same type are now on order, and that all the boilers will be eventually supplied with them. It will be seen that the superheating is not excessive, and can have no deleterious effect upon the lubrication of the cylinders or upon the gland packings. The temperature in no case rises to 400° F., even near the boiler, and there is, of course, a loss of heat in travelling to the engines.—*Engineering.*

LINK GRINDING MACHINE, GRAND TRUNK RAILWAY.

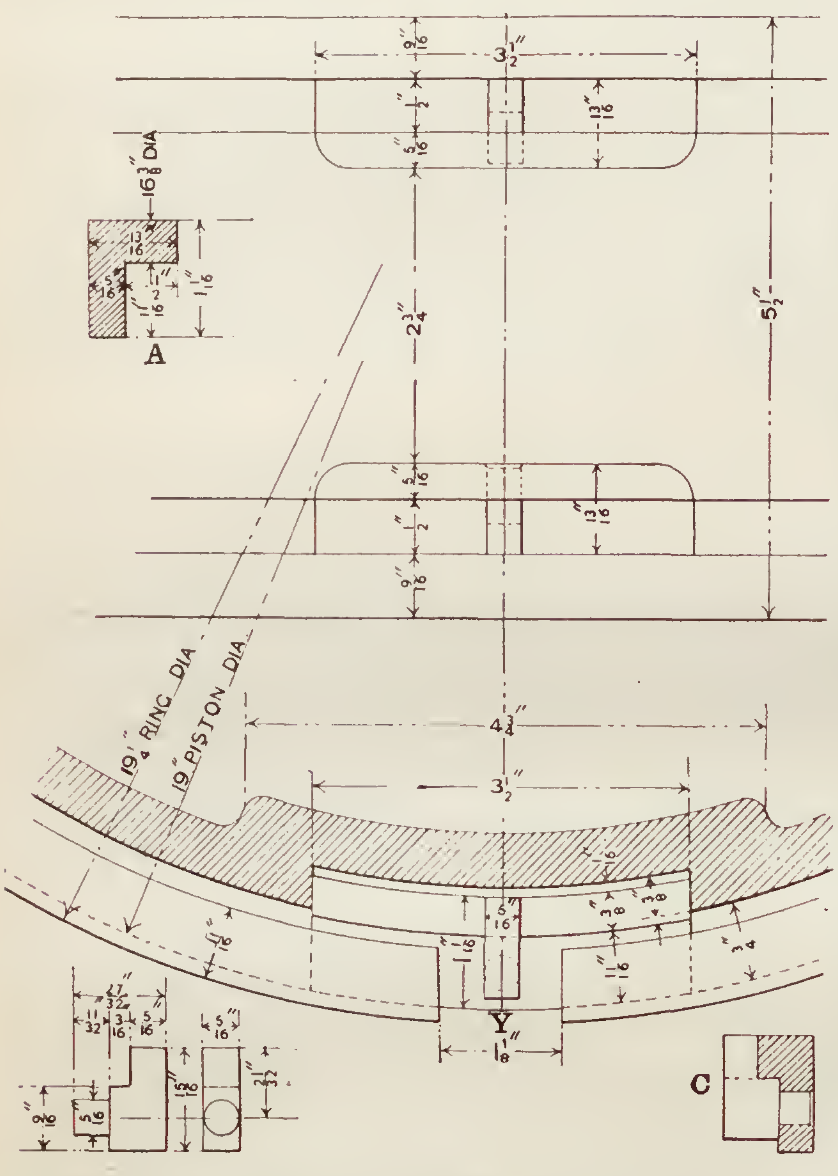
The half-tone engravings on the opposite page are reproductions of photographs of a link grinding machine that has recently been designed by Mr. William Aird, the foreman of the fitting and turning shop of the Grand Trunk Railway at Montreal, and built for use at that place. In its essential features it consists of a balanced, adjustable, radial arm for carrying the link or link block to be ground, that is given a vertical vibratory motion by means of a crank and connecting-rod, an emery wheel and a blower for removing the dust.

The radial arm is balanced and can be set to any desired radius and any length of stroke in the vertical plane equal to

the length to be ground. This arm makes about six strokes per minute. The emery wheel is also given a horizontal traverse, making about the same number of vibrations as the arm. The counterweight for the arm is suspended from above, and rises and falls in the cylindrical casing shown at the right-hand side of the rear view. The traversing of the emery wheel is accomplished by means of a pair of gimbal connections that appear on the front view. The emery dust and particles that are ground off from the hardened links and blocks are removed by an exhaust fan placed on the floor at the back of the machine. As will be seen from the engravings, the machine is so substantially built and is so rigid in all of its parts that the work is held accurately in position, and the officers claim that the results are as near perfection as can possibly be attained, both as regards the accuracy of the radius of the links and the fit of the blocks.

CYLINDER FOR CLASS P LOCOMOTIVE, PENNSYLVANIA RAILROAD.

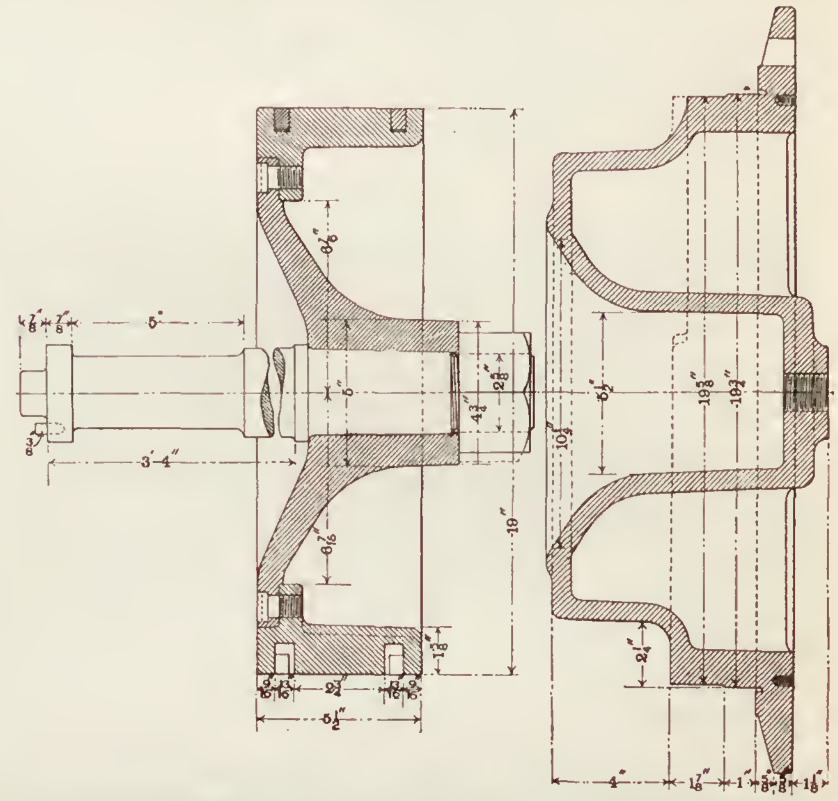
The cylinders of the new Class P locomotive of the Pennsylvania Railroad contain some interesting features and novelties. An attempt has been successfully made to design the cylinder so that radiation shall be avoided as much as possible, that the weight of the piston shall be greatly reduced, and that the clearance shall be at a minimum. The principal en-



PISTON PACKING, CLASS P LOCOMOTIVE, PENNSYLVANIA R. R.

graving shows the plan, cross, and longitudinal sections of the cylinder. In order to prevent radiation, all the hollow spaces contiguous to the steam and exhaust-pipes are filled with asbestos, thus maintaining the temperature of the metal as uniform as possible. In other details the cylinder differs merely in dimensions from the regular Pennsylvania patterns.

The diameter of the cylinders is 19 in., and the stroke 24 in. The construction of the piston and the front cylinder-head is clearly shown on an enlarged scale by the engraving of these details. The head sets into the counterbore, so that when the cranks are upon the forward centres there is a clearance of $\frac{5}{8}$ in. between the piston and the head. The former is dished and the latter projecting inward, so that approximately the same clearance is maintained across the whole diameter. The piston-rod has a taper of $\frac{1}{4}$ in. in its seat in the piston, and is so fitted as to be forced home with a pressure not exceeding 8 tons. It is further secured by a nut screwed on with eight threads to the inch, with the projecting end of the piston-rod riveted over. This nut is also prevented from turning by a $\frac{5}{8}$-in. pin, which is driven in at the bottom, and is directly in line with the joint of the piston-ring, so that the break in the joint block lies at the bottom of the cylinder. The piston rings are of the simplest character, as shown by the detail engravings. There are two split rings $1\frac{1}{16}$-in. deep with wearing surfaces $\frac{1}{2}$ in. wide, and split with a square



PISTON AND FRONT CYLINDER HEAD, CLASS P LOCOMOTIVE, PENNSYLVANIA RAILROAD.

opening $1\frac{1}{2}$ in. wide. At the bottom this opening is closed by a solid L-shaped block $1\frac{1}{16}$ in. high, and holding a stop to prevent the split ring from turning. The outside of the piston is turned to a diameter of 19 in., thus exactly fitting the cylinder, while the split rings are turned to $19\frac{1}{4}$ in. diameter and are sprung into the grooves. The packing is inexpensive, and when compared with the complicated steam packing with its numerous pieces that was used on many roads a few years ago, it shows that simplicity and effectiveness frequently go hand in hand.

FOREIGN NAVAL NOTES.

Another Torpedo-boat Record Speed.—Messrs. Thornycroft & Co. have again broken the speed record for steam vessels with the fourth of the torpedo destroyers, the *Boxer*, which they have just completed for the British Government. As compared with previous accomplishments, the gain is not very great, amounting to barely one-tenth of a knot, but having regard to the fact that the speed of steamships is closely approaching its ultimate limits, and the enormous efforts that are required to obtain even this fractional increase of speed, the record is worth reporting. The *Boxer*, which may be taken to represent the highest type of the torpedo-boat builder's art, has a length of 201 ft. 6 in., and a beam of 19 ft. In the course of an hour's trial, tested by six runs on the measured mile, three with and three against the tide, with a full load of 30 tons and a load draft of water of 7 ft. 2 in., the mean speed attained was 29.314 knots, equal to 33.5 statute miles per hour.

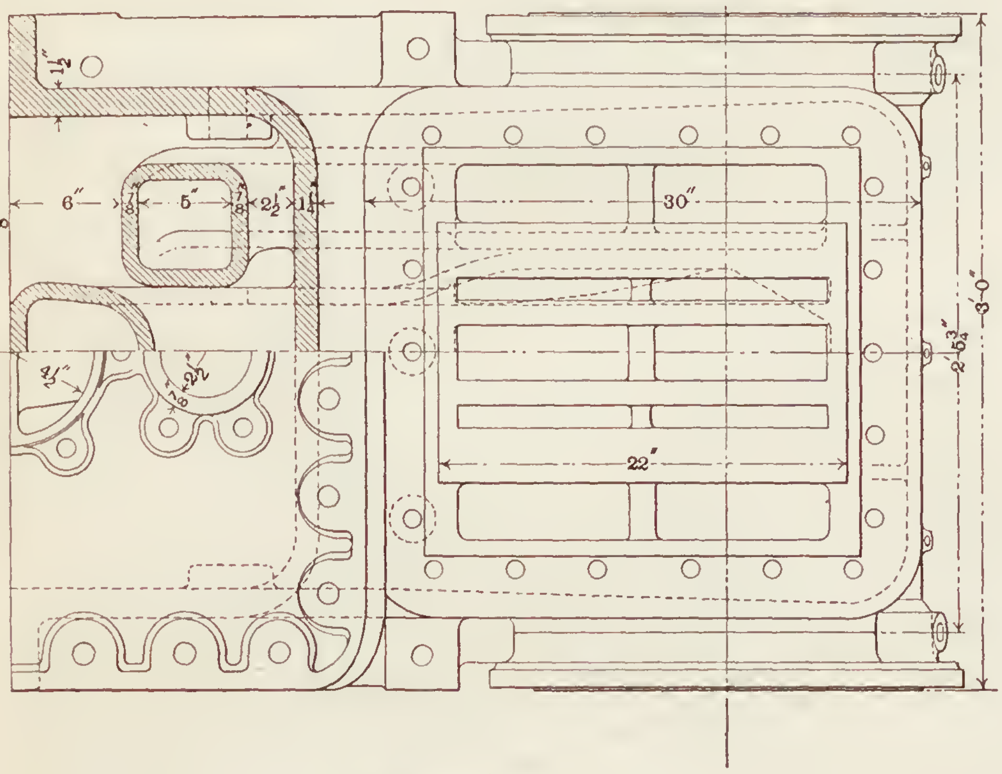
The *Ardent*, which was the predecessor of the present boat and the third of the series, made a speed of 29.182 knots, the engines making 407 revolutions, and developing nearly 5,000 I.H.P.—*Practical Engineer.*

The "Georgi Pobiedonostzeff."—The *Fremdenblatt* gives the following particulars of this new Russian ironclad, the construction of which was begun on August 12, 1889. It has steel armor from 8 in. to 16 in. thick on the sides, while the casemates are protected by 12 in., and the traverses by 9-in. to 10-in. plates. The total length of the ship, including the ram, is about 340 ft. It is 69 ft. broad, and 26 ft. 7 in. deep, with a displacement of 10,280 tons. It is supplied with two engines constructed in England, which will develop 10,600 H.P. under ordinary pressure, and 16,000 H.P. under forced

draft. The new man-of-war is armed with six 12-in. and seven 6-in. guns, as well as 14 quick-firing guns of English manufacture.

Naval Lessons from the War.—A correspondent who signs himself "Navalis" writes to the London *Times* that

"Accounts are pouring in from Chinese, Japanese and neutral sources as to the behavior of ships, armaments, and men



in naval action under modern circumstances. The following deductions seem to be fairly substantiated :

"Contrary to prophecy, large guns were not disabled through being dented or perforated by small projectiles propelled at high velocity.

"The unarmored ends of the two Chinese battleships remained intact after Yalu, and the vessels came out of action in a seaworthy condition as far as the structure of the hulls was concerned.

"Torpedoes were ineffective in an open sea action. Well-handled torpedo-boats, although losing some of their numbers, were effective against a fleet debarred from manœuvring.

"Japanese torpedo-boats were fired on, and driven from their objective by friendly warships, during an early and abortive attempt to enter the harbor of Wei-hai-wei.

"A flotilla of 14 torpedo-boats in the open sea was annihilated, with a solitary exception, by a small number of moderate-speed cruisers.

"The burst of one well-placed 12-in. shell disabled the shielded big gun of a protected cruiser and drove her out of action.

"The engines of the surviving ships of either fleet were intact, although fire was concentrated on the centres of the vessels.

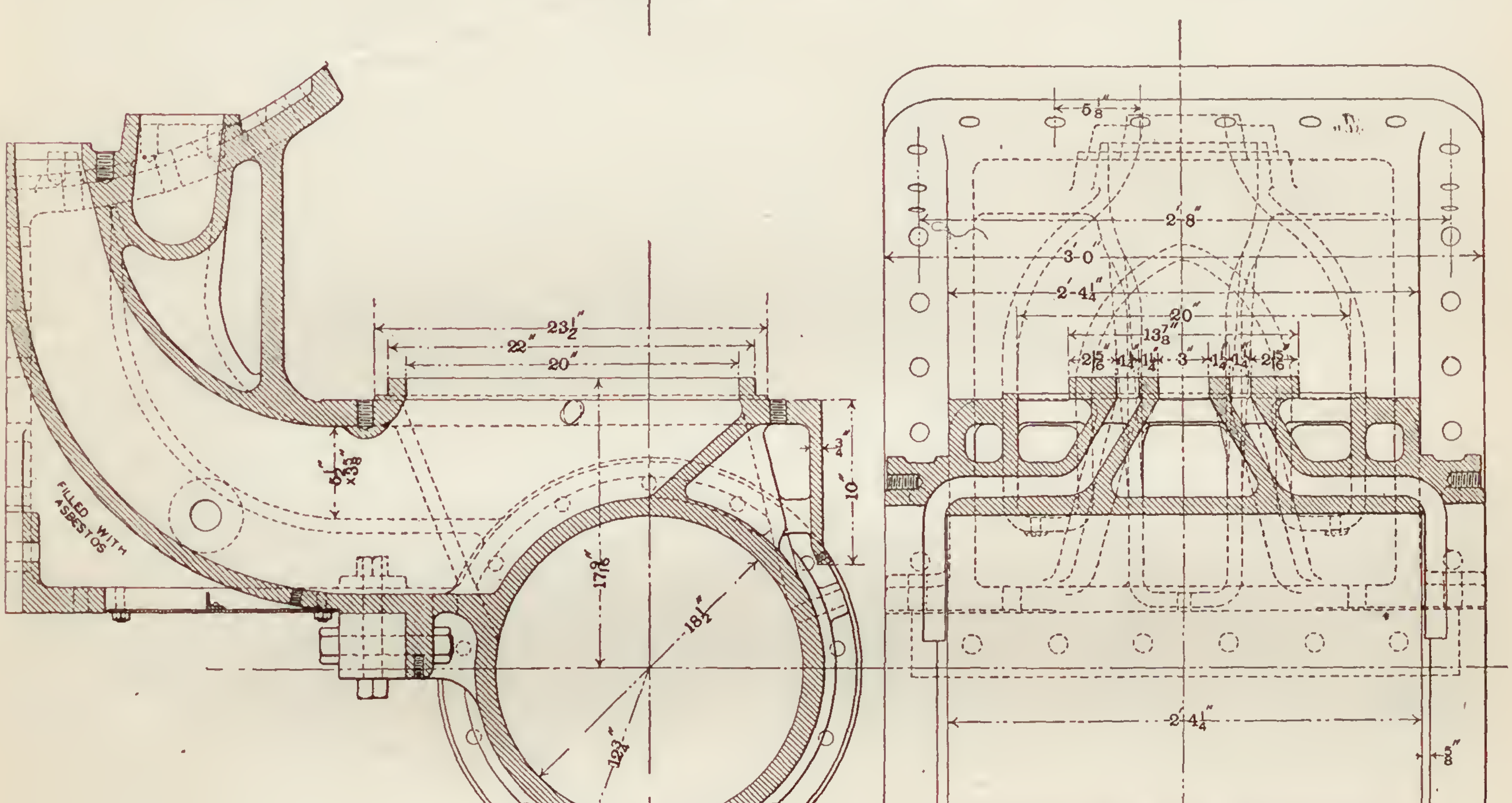
"Fighting tops were useless at the average range of the action as fought.

"Rudders were not damaged, although, in a few instances, the connections between the rudder and the bridge were impaired. Woodwork, either in the form of boats, bulkheads, or decks, was disastrous from the entailed conflagrations and splinters.

"Surplus ammunition above the hoist is a terrible element of danger.

"Extreme speed is not a constant requisite in a fleet action, but the power of moving rapidly for a special manœuvre is of supreme value."

Her Majesty's Steamship "Majestic."—The Portsmouth correspondent of *The Times* has recently given the following account of this ship, which was recently floated out of its dock at Portsmouth : "Not many years ago an armor-clad took four years to build, and she became, in some instances, partially obsolete before she left the stocks. Now the whole system has been changed. It was confidently thought at the time that the progress of the *Royal Sovereign* could not be surpassed. Sixteen months only elapsed between the laying down of the keel plate and the launch, and the work remaining to be completed, which naval experts stated could not be carried out in less than 15 months, was really accomplished in six. As a matter of fact, the 7,250 tons of the *Royal Sovereign*, in consequence of the large amount of armor that was fitted while in dock, represented the greatest weight ever put off the blocks up to the present moment. But the record of that battle-ship was eclipsed by that of the *Magnificent*, at Chatham, which was built in a twelvemonth, and took the water after having had 6,100 tons of material worked into her structure. The exceptional, feat, however, which has been performed in the construction of the *Majestic* is one of which the Portsmouth Dockyard authorities are laudably proud, because, not only does it transcend the Chatham achievement, but it constitutes an unprecedented exploit in



CYLINDER FOR CLASS P LOCOMOTIVE, PENNSYLVANIA RAILROAD.

armored ship-building. She was laid down in No. 13 dock on February 5, 1894, and has been floated out after an interval of five days less than a year with a displacement of 7,300 tons. It will thus be seen that, while she was a shorter period on the blocks, her launching weight was greater than that of the Chatham ship, and that she is, in fact, the most advanced of the vessels building under the Spencer programme.

"The *Majestic* is a sister ship to the *Magnificent*, launched at Chatham. The following comparative statement between her dimensions, weights, and armaments and those of the *Royal Sovereign*, which was floated out of the same dock by the Queen on February 26, 1891, will enable the reader not only to form a judgment as to her general characteristics as a fighting ship of the first class, but to perceive at a glance how it has been possible to build a larger, and in many respects a more formidable, armor-clad without very seriously increasing her displacement:

	Royal Sovereign.	*Majestic.*
Length	380 ft.	390 ft.
Breadth	75 ft.	75 ft.
Draft (mean)	27 ft. 6 in.	27 ft. 6 in.
" (moulded)	44 ft. 5⅜ in.	45 ft. 3 in.
Displacement	14,150 tons.	14,900 tons.
I.H.P. (forced draft)	13,000	12,000
I.H.P. (natural draft)	10,000	10,000
Speed (forced)	17¼ knots.	17¾ knots.
" (natural)	16¾ knots.	16½ knots.
Freeboard, forward	19 ft. 6 in.	25 ft.
" aft	18 ft.	18 ft. 6 in.
" midship	17 ft. 3 in.	17 ft. 9 in.
Length of armor belt	250 ft.	216 ft.
Depth of belt	8 ft. 6 in.	14 ft. 9 in.
Thickness of belt	18 in., 16 in., 14 in.	9 in.
Thickness of armor bulkheads	16 in. and 14 in.	14 in. to 12 in.
No. of casemates	4	12
Length of side armor above belt	141 ft.	nil.
Thickness of side armor above belt	4 in.	nil.
Thickness of casemates	6 in.	6 in.
" " armor screens.	3 in.	nil.
" " belt-deck	3 in.	4 in. on slopes, 3 in. on flats amidships to 2½ in. at ends.
" " barbettes.	17 in., 11 in., 6 in.	14 in. and 7 in.
" " conning tower	14 in.	14 in.
" " director tower	3 in.	3 in.
	Four 67-ton guns in barbettes, six 6 in. Q.-F. guns on upper deck, four in casemates on main deck, and 19 small Q.-F. guns.	Four 50-ton guns in barbettes, eight 6-in. Q.-F. guns in casemates on upper deck, four 6-in. Q.-F. guns on main-deck in casemates, and 28 small Q.-F. guns.
	Five above-water torpedo tubes, one in stern, and four on broadside.	One above-water tube in stern and four submerged tubes.
Weights in tons.		
Steel in hull	3,487	4,340
Wood decks, etc	590	570
Backing	140	160
Fittings	800	850
Hull, complete	9,650	10,180
Protective material	1,198	1,410
Armor	3,435	2,850
Equipment	530	600
Armament	1,410	1,500
Machinery	1,100	1,300
Coal, normal	900	900
" full	1,400	1,850

"Besides her additional length, the *Majestic* has important superiority in the auxiliary armament; in the protection of her guns, the casemates having been increased from four to 12, whereby the complete isolation of the gun detachments is secured; in depth of belt; and in coal-carrying capacity, which has been enlarged from 1,400 tons in the *Royal Sovereign* to 1,850 tons, in order to enable her to operate on an enemy's frontier or to steam long distances. Her total weight of protective material is also greater. Strong armored shields are fitted to the turntables and revolve with the guns, an advantage not hitherto possessed by battle-ships of similar dimensions. A saving of weight has been effected in the barbette armament, which is composed of four 50-ton 12-in. guns, which, Sir H. W. White has observed, had they been available in 1889, would probably have been preferred to the 67-ton ordnance. The new guns have a length of 35 calibre, and would have been made even longer had not the difficulties suggested by the ship constructors been considered to outweigh the advantages gained by the extra length from a gunnery point of view. They are capable of discharging a projectile at intervals of less than 1½ minute, are understood to be superior to the heavier types in penetration, and in consequence of their comparatively small weight have enabled the mountings and fittings to be proportionately reduced in size. The arrangements are such that the guns can be loaded and worked from any position by manual appliances, but without dispensing with the advantages obtainable from hydraulic power and fixed stations. An important economy in weight has been effected here; but unquestionably the most appreciable saving has been gained in the armored protection. The belt on the sides, though increased in depth, has been considerably reduced in length. This difference, however, is more than compensated for by the circular form of the armor bulkheads at the ends, which extend for some distance forward and aft and protect the foundations of the barbettes, and are a decided improvement upon the straight bulkheads of the *Royal Sovereign*. A sudden descent has been ventured from a *maximum* thickness of 18 in. in the vertical armor to a uniform thickness of 9 in. But this startling decrease has been justified by the blending of the turtle-back protective decks of the cruisers with the citadel armor of the battle-ships, and by the introduction of Harveyized solid steel armor, which greatly increases the power of the plates to resist penetration. Over 3,000 tons of this manufacture are distributed throughout the ship, fully protecting the machinery, guns, magazines, and crews. The spandrels produced between the sides and the rounded slopes of the turtle-deck will be filled with coal as a supplementary defence against shell fire. The *Majestic* will carry a complement of 18 boats, of which four are steamboats capable of acting independently of the ship for purposes of torpedo attack; and six search-light projectors worked by three dynamos of 600 ampères each. Her crew will consist of 757 officers and men.

"The propelling machinery, designed by Mr. A. Blechynden and built by the Naval Construction & Armaments Company, consists of two sets of triple expansion vertical direct-acting engines. The cylinders are: high-pressure, 40 in.; intermediate, 59 in.; and low-pressure, 88 in. diameter, having a stroke of 51 in. The valves are of the piston description for the high-pressure cylinders, and double-ported slide-valves for the others, and are actuated by the ordinary double-bar link motion. The back columns are cast of the inverted Y shape, securely tied together at the top by a wrought-steel plate, and form the piston-rod guide supports. The front columns are made of forged steel, and are strongly braced by horizontal and diagonal stays; while the bottom frames are of cast steel connected together by cast-steel girders and secured to the frames of the ship. The main and auxiliary condensers are formed of brass throughout, and possess a cooling surface of 13,500 sq. ft. and 1,800 sq. ft. respectively. There are also in the engine-rooms two main-feed pumps, two evaporators and distillers, four bilge and fire engines, two auxiliary air and circulating pumps, four powerful centrifugal pumps, one drain-tank pump, two ventilating fans, two reversing engines, and a brace of turning engines. In each of the four separate boiler compartments into which the ship is divided are two single-ended cylindrical return-tube boilers, 16 ft. 4 in. in diameter by 10 ft. 3 in. long. Each boiler is provided with four corrugated furnaces fitted with a couple of combustion chambers. The boiler-rooms are equipped with auxiliary feed-pumps and forced-draft fans. Supplementary machinery rooms are placed at the sides of the ship containing dynamos, air compressors, ventilating fans, and workshop appliances."

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

The object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publications will in time indicate some of the causes of accidents of this kind, and to help lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with the information which will help make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a great favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in March,

has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS IN MARCH.

City of Mexico, March 1.—A special excursion train filled with pilgrims to the shrine of Sacromonte, in Ameeameca, was derailed on its return trip to-day. The engineer, an American, was killed.

New York, N. Y, March 1.—The Washington express on the Royal Blue Line, on the Central Railroad of New Jersey, ran into a wrecked coal train at Bayonne this evening. Engineer William Thompson and Assistant Fireman Winfield Holland were killed. Fireman H. Orell suffered contusions about the body and head, besides having one leg broken.

Mobile, Ala., March 1.—William Lewis, an engineer on the Louisville & Nashville Railroad, was instantly killed to-day by the breaking of a side-rod on his engine.

Birmingham, Ala., March 3.—The boiler of a locomotive on the Central Railroad of Georgia exploded near Weems this morning. Engineer F. A. McGuire and Fireman William Reeves were killed.

Macon, Ga., March 5.—A southbound freight on the Western system of the Southern Railroad left the track just this side of Hilton this morning. The engine turned over on its side, and the engineer and fireman were hurt.

Dickinson, Tex., March 7.—A passenger train on the International & Great Northern Railway ran into an open switch at this point this morning. The engine turned completely over and pinned the fireman beneath it, where he was literally cooked alive by the escaping steam. The engineer was also badly injured.

Poughkeepsie, N. Y., March 7.—In a collision on the Bridge Road this morning at North Clinton Street between a special and a freight train, Engineer Robinson and Fireman Sisson were injured internally.

Newport, Vt., March 8.—A mail train on the Boston & Maine Railroad ran into a boulder at Smith's Mills, P. Q., this morning. The engine turned over, and Engineer F. J. Rooney and Fireman L. A. Emerson were confined in the cab and so terribly scalded that they died from the effects thereof in a few hours.

Augusta, Ga., March 9.—An engine hauling a freight train on the Central Railroad of Georgia broke away from the train at Barnett this morning. Walker Hackney, the fireman, who was just stepping upon the engine, was thrown down and run over by the entire train. He was instantly killed.

Altoona, Pa., March 9.—The boiler of an express engine attached to the Pacific Express exploded at Cove Station this morning. Engineer James Funk was killed and the fireman was badly injured.

Cumberland, Md., March 10.—A freight train on the Pittsburgh Division of the Baltimore & Ohio Railroad ran into a large rock that had fallen on the track near West Newton this evening. Engineer John Hughes was very severely injured, having his skull crushed and an arm broken, and it will be impossible for him to recover. The fireman was also more or less injured.

Poughkeepsie, N. Y., March 12.—Edward Hill, an engineer on the New York & New England Railroad, was killed while coupling his engine to a train at Glenham to-day. The fireman started the engine, and Hill was knocked down and run over.

Pittsburgh, Pa., March 13.—A shifting engine with its train was derailed at the foot of Locust Street, Allegheny, on the Pittsburgh & Western Railroad this afternoon. The engine turned completely over, and the fireman, Miller Zimmerman, was caught in the wreck and instantly killed.

Kingman, Ariz., March 13.—A freight train on the Atlantic & Pacific Railway was wrecked in Truxon Cañon near here to-night. Engineer Sullivan was instantly killed.

Oakland, Cal., March 15.—H. A. Croze, a fireman on the Southern Pacific Railroad, was thrown from his engine in the yards here to-day and instantly killed beneath the wheels of the tender.

Terre Haute, Ind., March 15.—There was a head-on collision between a switching engine and an express train on the Vandalia Line east of this city this morning. Both engineers were slightly injured.

Austin, Tex., March 17.—A mixed train on the Austin & Northwestern Railroad plunged through a bridge 20 miles from this city this afternoon. Charles Enloe, the engineer, and Tom Lunsford, the fireman, were seriously injured.

Keltys, Tex., March 17.—Charles Chaney, a fireman on the Tyler Southeastern Railway, was struck by a locomotive this morning. He sustained serious injuries, but will recover.

Bristol, Tenn., March 17.—A passenger train on the South Atlantic & Ohio Railroad was ditched on a curve this morning near the Natural Bridge Tunnel. Fireman Ed. Grubbs and Engineer Barton were fatally injured by jumping.

Palestine, Tex., March 18.—A freight train on the International & Great Northern Railroad was wrecked near Oakwoods this morning. The engine overturned, and Engineer E. Miller was slightly injured. The fireman, J. Majors, was hurt internally.

St. Louis, Mo., March 20.—A collision occurred between a freight and a stock train on the Chicago, Burlington & Northern Railroad early this morning near Hinckley, Ill. Fireman Williams was instantly killed and Engineer Spencer fatally injured.

Macon, Ga., March 20.—The south-bound vestibule train on the Southern Railroad was wrecked by spikes having been pulled from the rails near Jackson this morning. Fireman Roberts was badly scalded, and may die. The dispatch adds that this is the fourth wreck that has been caused on this road by malicious parties since March 1.

Cumberland, Md., March 20.—There was a rear-end collision between two freight trains on the Baltimore & Ohio Railroad near Magnolia Station this morning. J. H. Owen, the engineer of the colliding train, had his left foot terribly mangled, and was also injured about the shoulders. The fireman, Louis H. Brinkman, also had his foot smashed.

Dallas, Tex., March 21.—There was a collision between a passenger and a freight train on the Missouri, Kansas & Texas Railroad near Fisher this morning. The engineer of the passenger train was killed outright.

Connellsville, Pa., March 22.—A passenger train on the Baltimore & Ohio Railroad ran into a gravel train at Oakdale today. Engineer William Bradley and Fireman George Hutchinson of the passenger train were seriously injured.

Philadelphia, Pa., March 24.—In a freight wreck near Dillersville, on the Pennsylvania Railroad, Engineer James Hock and Fireman Robert McClain were injured.

Charlottetown, P. E. I., March 24.—A passenger train on the Prince Edward's Island Railroad ran into a cow near Traverse City to-day. Both the engineer and fireman were badly scalded and bruised, but not fatally.

Marysville, Cal., March 30.—A gang of train robbers held up a passenger train on the California Northern Railroad tonight. In the *mêlée* the fireman was wounded by a pistol bullet.

Our report for March, it will be seen, includes 28 accidents, in which 13 engineers and 9 firemen were killed, and 9 engineers and 14 firemen were injured. The causes of the accidents may be classified as follows:

Boiler explosions	2
Broken side-rod	1
Cattle on the track	1
Collisions	7
Coupling cars	1
Defective bridge	1
Derailments	4
Falling from engine	1
Misplaced switch	1
Obstruction on track	2
Run over	1
Struck by engine	1
Train robbers	1
" wreckers	1
Unknown	3
Total	28

PERSONALS.

Mr. Galen B. Owens has been appointed Supervisor of the Pennsylvania & New York Division of the Lehigh Valley Railroad, *vice* Mr. John M. Rahm, resigned. He will have charge of all of the tracks of this division in Pennsylvania.

Captain John G. Mann has been appointed General Manager of the Mobile & Ohio Railroad. Officers of the transportation, roadway, machinery, and traffic departments, and the Purchasing Agent will report to and receive their orders from him.

Many of the patrons of The American Engineer will doubtless remember Mr. Peter Flint, who for a number of years was a travelling representative of this paper, and who afterward occupied a position on the local staff of the New York *Tribune*. His old friends will be gratified to learn that he is now acting as private secretary for the Hon. William Brookfield, Commissioner of the Department of Public Works

in this city, a position for which his natural ability and the experience gained in his connection with THE AMERICAN ENGINEER eminently qualify him to fill.

MR. A. A. READ, Roadmaster of the Mahanoy Division of the Lehigh Valley Railroad, has been appointed Roadmaster of the Mahanoy, Beaver Meadow, and Hazleton Divisions, *vice* MR. I. O. MANDEVILLE, Roadmaster of the Beaver Meadow and Hazleton Divisions, resigned.

M. T. DAVIDSON, builder of the "Davidson" steam pump, removed his New York office and salesroom on May 1, from the quarters so long occupied at No. 77 Liberty Street to No. 133 same street, where the entire first floor will be occupied. This will provide for an extensive show-room, where a large and interesting exhibit of "Davidson" pumps in various styles and sizes will be made, and will afford every facility for the convenient and expeditious handling of the yearly growing business. Parties interested in high-class pumping machinery for all purposes are cordially invited to look in at the new quarters and examine the line of pumps which will be shown.

PROCEEDINGS OF SOCIETIES.

The British Institution of Naval Architects has awarded the gold medal for last year to Mr. D. W. Taylor, assistant to the Chief Constructor of the United States Navy, for his paper on "Ship-shaped Stream Forms."

Boston Society of Civil Engineers.—At the meeting held on March 20 the Secretary read a communication from a committee on standard gauges for thickness of the American Society of Mechanical Engineers, requesting the co-operation of this Society in the effort to abandon the system of arbitrary gauges, and to secure the adoption of a decimal system giving the actual thicknesses and diameters of the pieces. After a short discussion it was voted to refer the communication to the Board of Government, to report back to the Society what action was desirable.

Master Car-Builders' Convention.—Arrangements have been made by the Standing Committee of the Supply Men's Association for an ample amount of space for those wishing to make exhibit at Alexandria Bay during the June Conventions of the Master Car-Builders' and Master Mechanics' Associations. Mr. Charles W. Crossman, proprietor of the Crossman House, has donated the use of the Pavilion, a building 15 ft. wide by 60 ft. in length, with a veranda 9 ft. in width running entirely around it, in addition to which he will, if found necessary, raise a large tent on the lawn. To insure prompt delivery, consignments should be marked Alexandria Bay, N. Y., *via* Clayton, care of The Crossman House, where they will be received by a special committee stationed on the ground at least a week in advance of the Conventions and transported from and to the wharf free of charge. For space or further information address W. C. Ford, Secretary, 29 Broadway, New York City, N. Y.

The American Railway Association has become a member of the International Railway Congress. This Congress, which is to meet in London on June 26, 1895, includes railway officials from all parts of the world, 36 nations being represented in its membership. Many subjects of great interest will be discussed. The Prince of Wales has consented to preside at the opening ceremonies. The delegates so far chosen to represent the American Railway Association are Mr. H. S. Haines, President of the Association and Vice-President of the Plant System, and Mr. W. F. Allen, Secretary of the Association and Manager of the Official Railway Guide. The Association is entitled to eight delegates, and the names of the other six selected will probably be announced shortly. The following named American railway companies are announced as members of the Congress, and are entitled to send delegates on their own account in addition to the representatives of the Association: The Louisville & Nashville; Pennsylvania; Denver & Rio Grande; New York, New Haven & Hartford; Chesapeake & Ohio; Fitchburg; Richmond, Fredericksburg & Potomac; Arizona & Southeastern; Los Angeles Terminal. The session will be held in the Imperial Institute in Kensington. The last session of the Congress was held at St. Petersburg, Russia, in 1892, and the one before that at Milan, Italy.

Engineers' Club of St. Louis.—At the meeting of March 20 the Secretary reported that a "letter from the American Society of Mechanical Engineers, dated February 21, 1895, to the Engineers' Club, asks us to co-operate with their Society in the matter of recommending a gauge system based on actual thickness and diameters and state it in a decimal system. Your committee are unanimous in the opinion that the old arbitrary gauges now in use are apt to lead to confusion, and the course recommended by the joint committee of the American Society of Mechanical Engineers and the Railway Master Mechanics' Association is the right way out of the difficulty. It is absolutely necessary in mechanics and in business that standards should be plain, easily understood, and of as wide acceptance as possible. Since it is not at present feasible to introduce the French system of measures used all over the Continent of Europe, in our practice, there can be no doubt that giving thicknesses in thousandths of the inch is the best practical method of designation.

"Your committee therefore proposes the following resolution:

"*Resolved*, That the St. Louis Engineers' Club recommends to its members, and urges upon all persons using a gauge system to abandon the use of arbitrary gauges and to give the actual thicknesses and diameters in thousandths of the inch.

"*Resolved*, That the Secretary of the Club be instructed to send copies of this resolution to the secretaries of the other associated societies, requesting them to concur, and to the Secretary of the American Society of Mechanical Engineers."

Professor W. S. Chaplin, Chancellor Washington University, then addressed the Club on the subject of German engineering schools and engineering education in general. He visited Germany in the summer of 1894 and took occasion to make a special study of the technical high schools in Berlin and Hanover. He was first struck with the size and magnificence of the buildings, the idea being that expenditures of this character would impress the people favorably, and tend to make the schools rank favorably in comparison with the older universities. The schools were provided with elaborate collections of models, representing all sorts of machinery. These models, however, were not used by the students, but by the professors only. Chemistry was taught to engineering students by lectures only. No students, except those intending to be chemists, were allowed to handle chemicals. The theses were accompanied by very fine drawings, but it seemed that all the designs and computations were made by the professors, the student simply executing the drawings under the immediate direction of the professors. It was necessary to pass two important examinations, one at the end of two years and the other at the end of four years, at which time the student graduated, and took the State examination. It was necessary to pass the latter if the student expected to follow the profession and find employment.

The professors in the technical high schools were looked down upon by those in the universities. Engineers were considered technical and not scientific men. In a recent discussion among German engineers regarding engineering education, it was considered that a groundwork in theory was absolutely essential, but it was necessary also that the student be taught the application of the theories to every-day problems.

German engineering students put in from 41 to 44 hours per week at school, while 35 hours is considered large in this country. Besides this, it is necessary to do a considerable amount of home work at night.

The professor had expected to learn many things of value, but was disappointed. He thought that, on the whole, the training given by American engineering schools was much better suited to American conditions. The technical high schools are entirely distinct from the universities. There are no graduate students. Instruction is simply by lectures, text-books being used only in mathematics. The standard of entrance is higher than in our schools, and the course of study more thorough, but the field covered is not as wide or as general. The schools are supported almost wholly by government grants, the fees paid forming probably not to exceed 10 per cent. of the income.

AT the meeting of April 3, Professor J. H. Kinealy addressed the Club on the Different Methods of Determining the Heat Value of Fuels. Three plans are in common use: the Analytical, Bertier and Calorimetric. In the first method the calorific power is computed from the chemical constituents of the fuel, they having first been determined by analysis. This process was open to the criticism that the heat value of pure carbon had been shown to vary as much as 3 per cent., depending upon the condition of the carbon. This computation also neglected the sulphur. On the whole, however, he considered this plan the best of the three.

In the second, or Bertier method, the coal was burned in the presence of litharge, the heat value being assumed to be proportioned to the amount of oxygen absorbed from the litharge.

This principle has been shown, however, to be erroneous, but the method nevertheless gives good comparative results.

The apparatus used in the third method is usually the Thompson calorimeter, in which the coal is burned in such a way as to give up its heat to a surrounding body of water of known weight, the rise in temperature of which is noted. This method was shown to have a considerable error, depending upon the temperature of the water used and the heat absorbed by the apparatus itself. Its accuracy depends upon very close reading of thermometers. This method assumed that complete combustion of the coal occurred, which the speaker doubted. This possibility he proposed to investigate further by analyzing the discharge gases.

Manufactures.

THE DIAMOND PRESSED-STEEL BOLSTER FOR BODIES AND TRUCKS OF FREIGHT CARS.

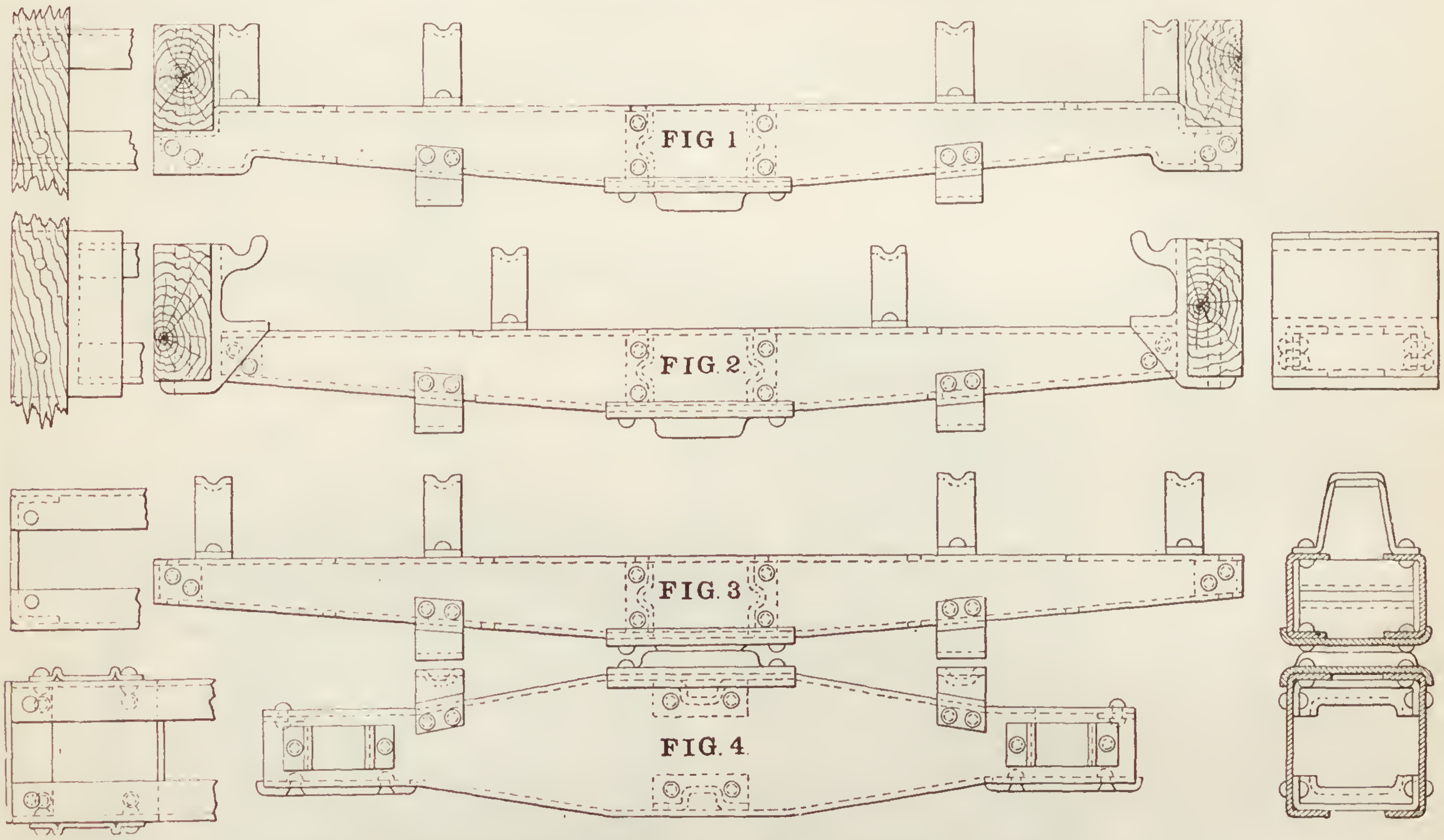
The Schoen Manufacturing Company, of Pittsburgh, for some seven years past has been engaged in manufacturing specialties in pressed steel. Among these are truck and body bolsters for freight cars. The causes which led up to their manufacture are stated as follows in one of their circulars :

" Bolsters, as they are commonly used to-day, are composed of wood and iron ; and owing to their construction, are subject invariably to the shrinkage of the wood, and the consequent loosening of nuts, and therefore soon disintegrate. The integrity of the structure is entirely dependent upon everything being kept tight, which is next to impossible, the inevitable result being, in a comparatively short time, that the bolsters must be renewed in whole or in part. Every one having charge of the repair of freight cars knows to what extent this is true."

In a report to the Master Car-Builders' Association the Committee on Freight Car Trucks recommend the introduction of steel or wrought-iron bolsters, and say :

" The committee made personal inspection of 61 different styles and makes of freight trucks, largely composed of wood transoms and bolsters, and every truck was more of less defective on account of the parts shrinking, causing loose bolts, and many other parts split, checked, cracked, splintered, worn away, warped, etc., and we therefore recommend that timber not thoroughly seasoned is unfit for car-truck construction to produce economic results, and as builders cannot use seasoned timber, we would recommend the introduction of steel or wrought iron in place of green, unseasoned timber."

To overcome these difficulties the Schoen Manufacturing Company have devised the system of bolsters represented in the engravings herewith. These are made of steel plates pressed into a channel form. Fig. 1 represents a body bolster with the form of ends which are required when side sills are not more than 2 in. deeper than the intermediate sills. A plan view of one end is shown on the left side. Fig. 2 is an elevation of a body bolster showing the style of bracket which is used when the side sills of the car-body are more than 2 in. deeper than the intermediate sills. A plan of the end is shown on the left side, and an end view of the bracket on the right. Fig. 3 represents a form of body bolster which is used when the sills are all of the same depth. A plan of end is shown on the left and a section on line A B on the right. Fig. 4 is an elevation of a truck bolster which is raised in the middle, but they are also made straight when required. A plan of the end and a section on A B are also shown.



THE DIAMOND PRESSED-STEEL BOLSTER FOR BODIES AND TRUCKS OF FREIGHT CARS.

The advantages claimed for pressed-steel bolsters are a reduction of cost of repairs and dead weight, greater mileage and more service of car, thus giving a better riding car, and the bolsters have a scrap value when they are condemned.

THE HOGAN WATER-TUBE BOILER.

The Hogan Boiler Company, of Middletown, N. Y., which has for some time past been engaged in exploiting and perfecting their boiler, threw open their works on April 9 for the inspection of representatives of the trade press, mechanical engineers, representative manufacturers, and steam-users. About a car-load of persons belonging to these classes availed themselves of the invitation and were present at that time. After partaking of the hospitality of the company at the hotel in Middletown, the visitors were taken in conveyances to the works, where a boiler has been erected and which was subjected to the inspection of visitors and to some tests in firing and evaporation. Owing to the limited time these tests could not be satisfactorily carried out, although every provision had been made for doing so.

The boiler consists of two cylindrical " distribution drums" which are placed longitudinally on each side of the grate, a few feet above it. Another single drum, called a " steam extractor," is placed a considerable distance above the distributing drums, and the upper and lower ones are connected together by tubes bent into suitable forms for that purpose.

The drums and pipes are enclosed in brick-work and have circulating pipes outside.

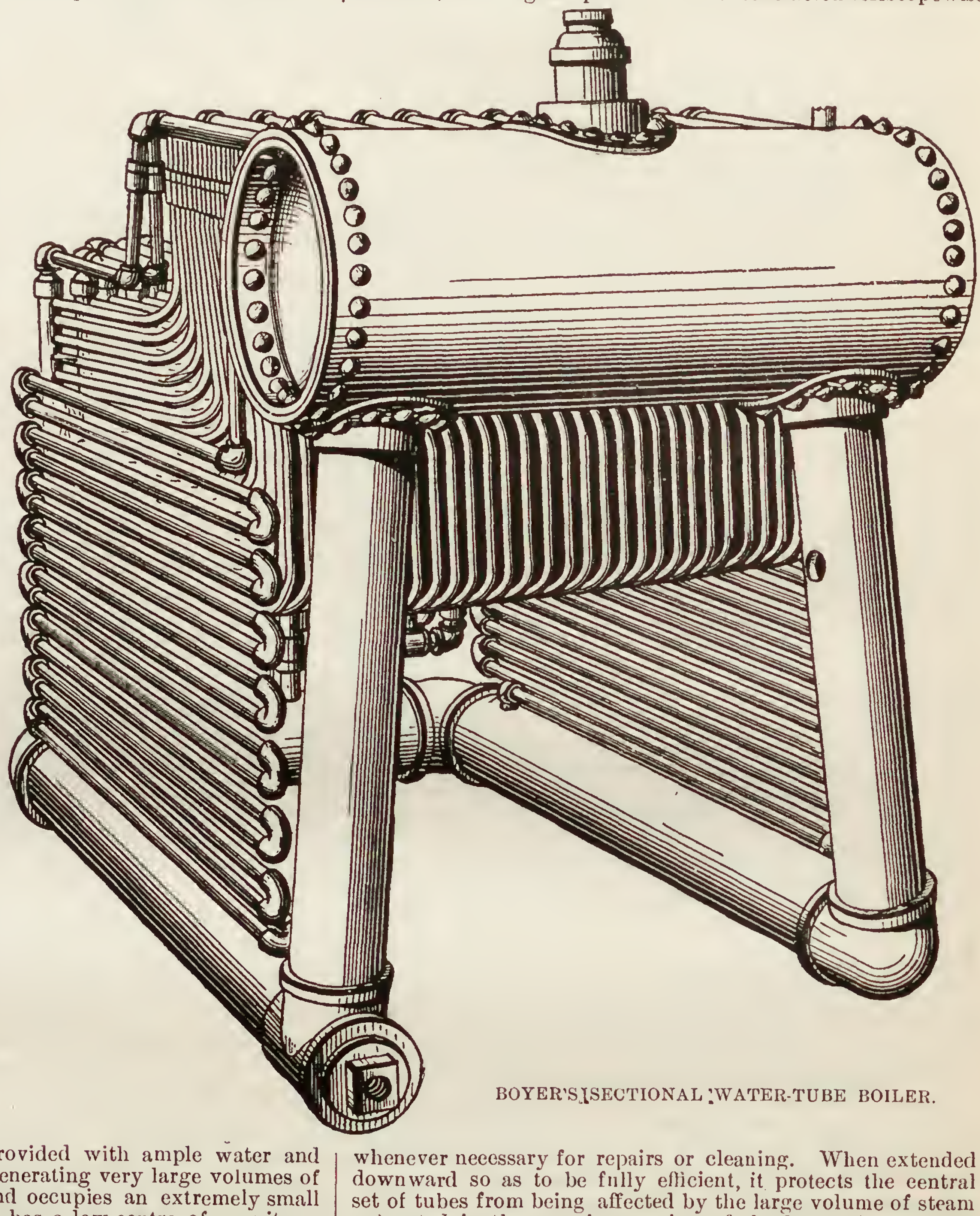
After inspecting the shops and the boiler, which was under steam, and making some partial tests, the company were taken to the asylum near Middletown to see a boiler plant which has been erected there.

The Hogan Company will now put this boiler on the market, feeling confident that it will do all that has been expected of it.

BOYER'S SECTIONAL WATER-TUBE BOILER.

When the steam yacht *Rex*, exhibited by L. Boyer's Sons, of New York, at the Chicago Exposition, was being designed, it was found that, in order to maintain the speed of 31 miles per hour, a piston speed of 1,500 ft. per minute would be required, and that in engines of only 9 in. stroke. The boiler requirements to furnish this amount of steam at 300 lbs. pressure were such that of the many pipe boiler builders there was only one firm who would guarantee to accomplish this, and their boiler would weigh 9½ tons, a weight sufficient to prevent great speed by so small a boat Chief Engineer Kaine was thus confronted with a problem the solution of which once more demonstrated the truth of the old saying, "Necessity is the mother of invention." The boiler thus designed weighed only 2⅛ tons; is made of wrought-iron tubes screwed together in sections and without any dead ends. It has no joints directly attacked by the heat from the furnace. It is provided with a steam drum of best steel plates double riveted, which is entirely removed from the heat of the furnace. There is a sufficient water space, a large combustion chamber with ample and very efficient heating surface. The casing is of sheet iron lined on the inside with the best non-heat-conducting material, and is easily removed for repairs. This boiler is exceedingly simple in construction. There is an arrangement whereby access may be had to any part of the boiler with the greatest ease and with the least delay, for the purpose of cleaning or repairing, or for the removal of any one or more of the parts and the substitution of other duplicate portions. This boiler is so designed that, while provided with ample water and steam space, it is capable of generating very large volumes of steam with great rapidity, and occupies an extremely small floor area and cubic space. It has a low centre of gravity, a short, rapid and perfect circulation. This boiler is especially adapted to marine engines of very high speed, to be used upon boats of light draft, when the utmost economy of space and weight, with ample strength, entire safety, a greatly amplified heating surface, a capacity of generating large volumes of steam with the utmost rapidity and uniformity, and an economical consumption of fuel are all essential.

The *Rex* recently cruised from Albany, N. Y., to New York City, a distance of 144 miles, on 1,000 lbs. of coal, thus showing the unparalleled economy of this boiler. This simple and perfect steam generator is a comfort to the engineer, can be taken care of by any one, and can be repaired at any time or place, its fittings being of standard sizes.



BOYER'S SECTIONAL WATER-TUBE BOILER.

Recent Patents.

MOORE'S VERTICAL WATER-TUBE BOILER.

Mr. Matthew Robert Moore, of Indianapolis, Ind., has patented the form of boiler shown by fig. 1, which he describes as follows:

"The lower part is a peculiarly shaped drum, *B*, of an inverted bottle form, a central portion, B^2, of less diameter extending down below the grate, while the main portion *B* is held at a considerable height above the fire. The contracted portion of the lower drum is incased by fire-brick *A'*. The mid-height of the boiler is a set of vertical tubes *D D*. The upper part *M* is a drum in which a liberal surface is presented for the disengagement of the steam from the water. I promote the descent of the water through the tubes *D'* near the centre by means of a petticoat rim, *E*, made in horizontal sections, allowing the petticoat to be contracted telescopewise whenever necessary for repairs or cleaning. When extended downward so as to be fully efficient, it protects the central set of tubes from being affected by the large volume of steam generated in the exterior portion of the lower drum. The steam generated there rises through the series of tubes above, and insures an active upward current of steam and water through those tubes, and further steam is generated in these tubes by the circulation of the gaseous products of combustion through the spaces between them. The steam and water thus rising separate in the upper drum and the steam is conveyed away for use. The water descends through the central tubes of the series, which tubes are over the central portion of the bottom. The small quantity of steam generated in these central tubes is carried down by the descending current, and moving outward in the lower portion rises and contributes to the vigor of the strong rising columns in the tubes near the periphery of the series. The non-conducting protec-

tion A' between the central portion of the boiler and the annular furnace which surrounds it protects the fire from being too much cooled along the inner edge and allows all portions of the grate surface to be about equally efficient. The fire-brick also preserves that portion of the boiler from being overheated in any exigency. The annular grate L is slightly inclined inward. A shaking grate is preferred, but this is not material. The annular furnace is fed, cleaned, etc., through doors in the outer casing. A perforated protection of fire-brick, A^3, is extended over the fire at a proper height. At the mid-height of the tubes the masonry wall is extended inward, so that it comes nearly or quite in contact with the outermost tubes. The hot gaseous products of combustion deflected inward thereby are caused to circulate among the tubes. They are afterward led outward and upward around the exterior of the upper drum and finally collected and conveyed away through a central stack at the top.

"A pit a is provided below the boiler to facilitate the removal of the bottom plate B^3 in cleaning or repairing. When a number of my boilers are set together, the pits a may be left open and communicate with a tunnel through which the ashes can be conveniently removed without the annoyance of hauling them out through the fire-room."

The patent is No. 535,115, and is dated March 5, 1895.

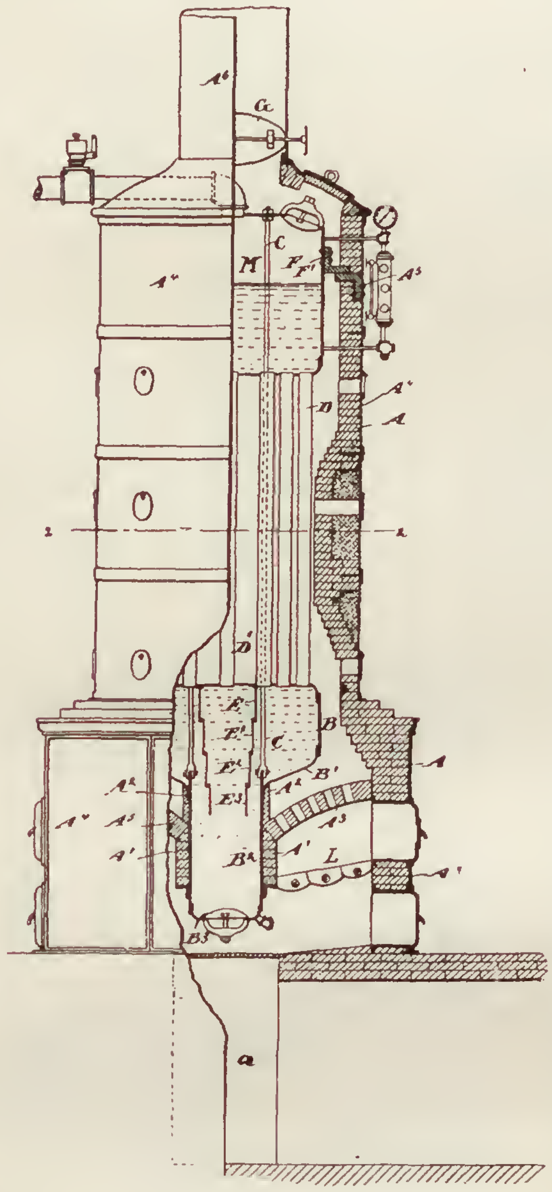


Fig. 1.
MOORE'S VERTICAL WATER-TUBE BOILER.

MUMFORD'S WATER-TUBE BOILER.

Fig. 2 represents another form of water-tube boiler patented by A. G. Mumford, of Colchester, England.

"This invention," he says, "relates to an improvement in that type of water-tube boilers having a steam collector, A, and two water chambers C and C', the latter each connected to the former by a series of small tubes D and one or more circulating pipes F, and it consists in arranging the said water tubes in groups to form self-contained elements by connecting their ends to two boxes or chambers, which are connected respectively with the steam collector and water chambers by single pipes E fitted with flanged or other suitable joints, the said boxes respectively being arranged side by side to form the top and sides of the fire-box or furnace G, the object being to facilitate the repair of the boiler in case of accident to any of the tubes.

"Each of the boxes C on each side of the boiler is connected with the adjacent box C' by a group of curved tubes D, the said tubes being of such a curvature that they can readily be withdrawn or inserted through one or other of the said boxes after the removal of the cover thereof. It will thus be seen that one box C, one box C', and one group of tubes D forms a self-contained element.

"The pipes E and E' connecting the boxes C and C' with the steam collector A and water chambers respectively may run into or be connected to the covers of the said boxes, but they are preferably arranged to run into or to be connected to the boxes themselves so as to leave the covers thereof free for removal without breaking the joints e or e'.

"The steam collector or reservoir A is connected with the water chambers B and B by means of one or more circulating pipes F. In a single boiler two such pipes are used, and they are preferably arranged at the front end of the boiler, as shown by fig. 2, but in a double-ended boiler they are preferably arranged between the two parts of the boiler. When two circulating pipes are used, as shown by fig. 2, the two chambers B and B are sometimes connected together at the back end of the boiler by a pipe such as b."

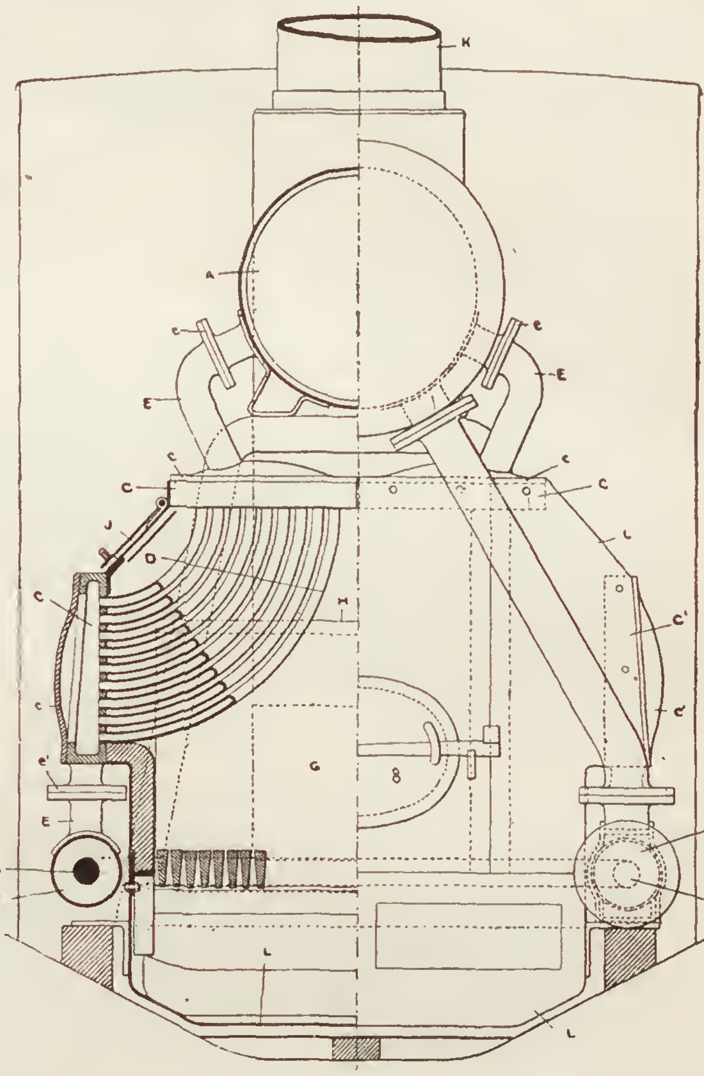


Fig. 2.
MUMFORD'S WATER-TUBE BOILER.

The date of the patent is March 5, 1895, and it is numbered 535,068.

BULLA'S LOCOMOTIVE.

Mr. Melbern B. Bulla, of Yuma, Arizona Territory, has patented the design for locomotive shown by fig. 3. This is a compound engine with two high-pressure cylinders outside of the wheels and frames and two low-pressure cylinders between the frames. In order to get as wide a fire-box as possible he places the frames outside of the wheels. The pistons of the high-pressure cylinders are then connected to cranks C on the ends of the main driving-axle D, as shown in the engraving. The pistons of the low-pressure cylinders are connected to cranks on the main axle, the inside and the outside cranks on each side being placed opposite to each other, so that the pistons balance each other. The chief peculiarity of this plan, though, is the arrangement for dispensing with the use of coupling-rods. To accomplish this end the front driving-wheel E is connected with the corresponding rear drive-wheel by friction wheels L, secured on a transversely extending shaft L^2 mounted to turn in suitable boxes N fitted to slide vertically in suitable bearings arranged in the side frames F of the locomotive.

The lower ends of the bearings N are engaged by springs O, each held in a frame, P, connected at its upper end with the piston-rod Q of the piston in a steam cylinder R arranged on the locomotive, the said cylinder being connected by a steam-pipe, S, with the corresponding steam-chest of the high-pressure cylinder A, so that whenever live steam is admitted to the steam-chest of the high-pressure cylinder, then it also passes through the pipe S into the lower end of the cylinder R to force the piston therein in an upward direction, to lift the frame P and springs O to move the boxes N upward and to cause the friction roller L to move in firm frictional contact with the peripheral surfaces on the front and rear driving-wheels E and K.

When the steam is shut off from the steam-chest of the high-pressure cylinders, by the engineer closing the throttle, then the pressure on the piston in the cylinder R is released and the frame P can slide downward by its own weight, so

as to relieve the pressure on the spring *O* and boxes *N* to permit the friction wheel *L* to move out of frictional contact with the sets of front and rear driving-wheels. Each friction wheel has a diameter about 6 in. greater than the distance between the periphery of the front and rear driving-wheels, and each friction wheel is placed below the centre of the driving-wheels.

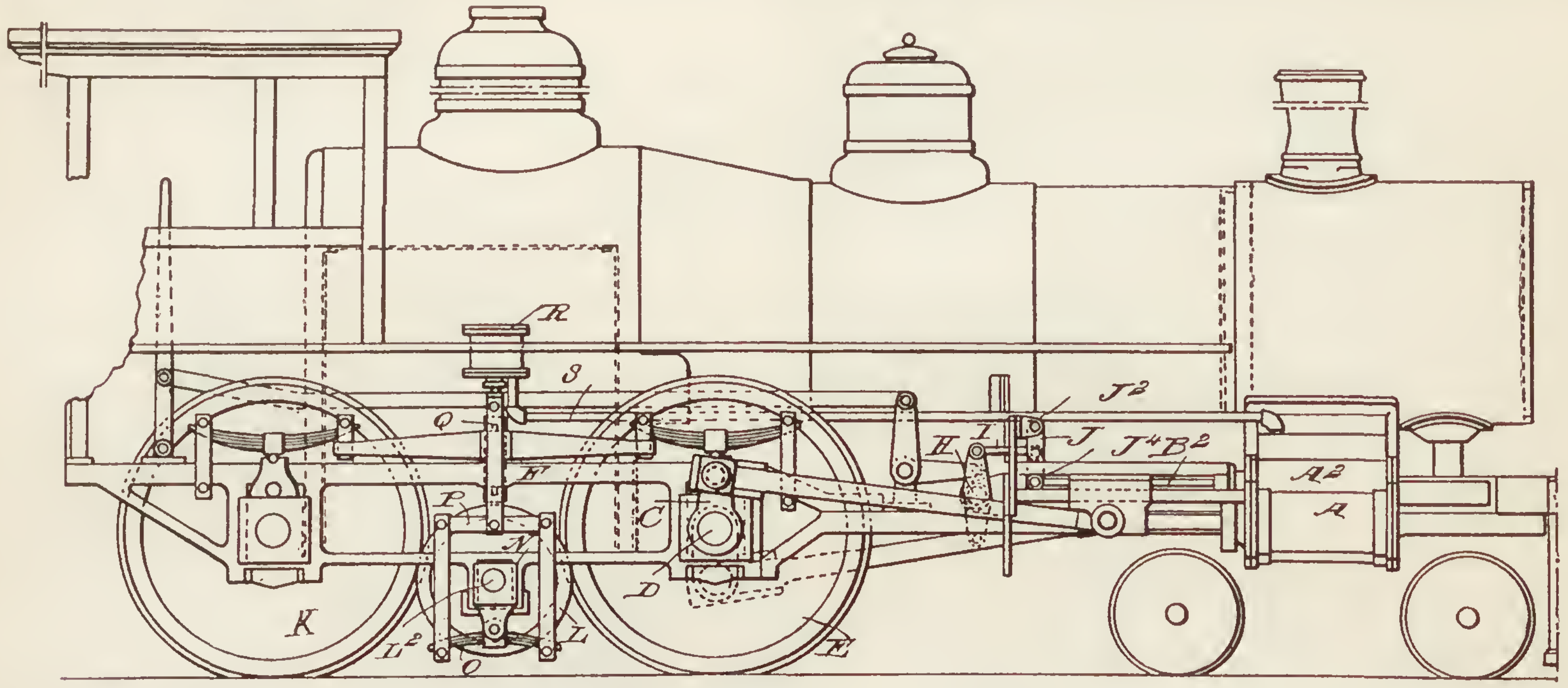


Fig. 3.

BULLA'S LOCOMOTIVE.

It will be seen that by the construction above described the friction wheels *L* are held up against the driving-wheels *E* and *K* with sufficient force to prevent their slipping, and when the steam is shut off from the high-pressure cylinders, then the friction wheels will drop down clear of the driving-wheels and allow the engine to run with diminished friction.

By the construction described no side rods and no pins in the back driving wheels *K* are necessary, and no counterbalancing is required.

The date of the patent is March 12, 1895, and its number is 535,668.

SCHMIDT'S DOUBLE-ACTING STEAM-ENGINE.

The operation of this engine is similar to that of a compound engine with a receiver, but with the difference that one side of the low pressure is constantly under the influence of the low-pressure steam piston, and that the space between that side of the low-pressure piston and the opposite cylinder-cover forms part of the receiver, the capacity of the latter being, therefore, a variable one.

Fig. 4 represents a longitudinal section of the cylinders, steam-chest, and receiver.

The objects of the invention are, first, to provide an engine, which is specially adapted for the use of superheated steam; and, second, to cause in such engine the high-pressure cylinder to be cooled by the low-pressure steam, and the low-pressure cylinder to be heated by the receiver steam.

a is the high-pressure cylinder, within which works the hollow high-pressure piston a^3 of plunger-like configuration. This piston extends into the low-pressure cylinder and carries at its end the low-pressure piston b^3, by which latter the said cylinder is divided into two compartments or chambers b' and b^2. Chamber b^2 extends as a matter of course up into the hollow plunger and constitutes the variable receiver part mentioned. This part is in constant communication with the receiver proper *c* by a port, *d*, while the high-pressure cylinder *a* and the annular chamber b' of the low-pressure cylinder are alternately brought into communication with the receiver proper *c* by the hollow slide-valves *e* and *f*. These valves are made integrally, and are operated simultaneously by one and the same valve-rod *g*.

Supposing the valves be in their highest position, the high-pressure steam entering the engine at *h* will flow into cylinder *a* through the groove around the contracted portion of valve *e* and through the channel *i*. During this time the low-pressure steam contained within the receiver *c* will flow into the annular chamber b' through the passage *l*, acting therein on a piston surface of an area equal to the difference between the working surfaces of the two pistons. As the chamber b^2 is constantly filled with the low-pressure steam, there is consequently a pressure counteracting that of the high-pressure steam, the said counteracting pressure being produced by the influence of the low-pressure steam upon the lower side of the high-pressure piston. During the expansion period the valves *e* and *f* are in their middle position, as shown in the drawing. If thereafter the valves are lowered, the high-pressure cylinder *a* will by means of the passage *i* and the internal opening in the valve *e* come into communication with the receiver proper *c*, while the chamber b' of the low-pressure cylinder communicates through the passage *l* the annular groove in the valve *f* and the outlet *k*, either with the atmosphere or with a condenser. The chambers *a*, receiver *c*, and chamber b^2 are thus filled with steam of equal pressure, and the piston on its return stroke is acted on by a pressure constituted by the influence of the low-pressure steam on a piston surface of a size equal to the difference between the working surfaces of the two pistons.

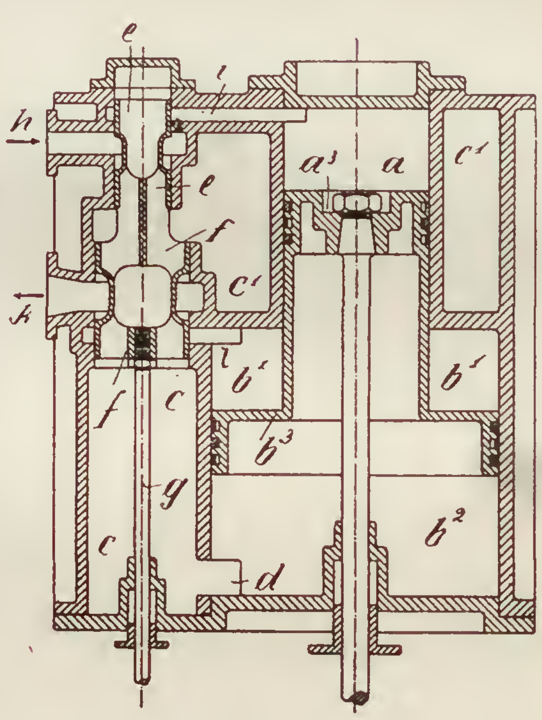


Fig. 4.

SCHMIDT'S DOUBLE-ACTING STEAM-ENGINE.

Besides the chamber b^2 of the low-pressure cylinder, the annular space c' around the high-pressure cylinder *a* also forms part of the receiver. Therefore the latter cylinder as well as the small piston is constantly cooled by the low-pressure steam present within said space c', while the low-pressure steam present within chamber b^2 constantly heats the low-pressure cylinder as well as the large piston. By reason of these functions of said spaces, the engine is specially adapted to be driven by superheated steam. There is, then, the further advantage that stuffing-boxes may entirely be dispensed with.

This form of engine is the invention of Mr. Wilhelm Schmidt, of Wilhelmshöhe, Germany. We are not able to say with certainty whether this is the kind of engine—but presume it was—which was tested in connection with the boiler which was illustrated and described in our issues of February and April, and of the performance of which reports are given in the former and also in this number of THE AMERICAN ENGINEER.

The number of Mr. Schmidt's patent is 535,864, and it is dated March 9, 1895.

AERONAUTICS.

UNDER this heading we shall hereafter publish all matter relating to the interesting subject of Aerial Navigation, a branch of engineering which is rapidly increasing in general interest. Mr. O. Chanute, C.E., of Chicago, has consented to act as Associate Editor for this department, and will be a frequent contributor to it.

Readers of this department are requested to send the names and addresses of persons interested in the subject of Aeronautics to the publisher of THE AMERICAN ENGINEER.

SOME EXPERIMENTS ON THE EFFICIENCY OF AIR PROPELLERS.

By HENRY GOLDMARK.

AIR screws or propellers have long been a favorite form of mechanism in projects for artificial flight, but experimental data, from which the relative efficiency of different types of screws could be determined, have hitherto been almost wholly lacking.

Even in the case of propellers working in the water, though used on so extensive a scale in steam navigation, the mathematical analysis is quite incomplete ; so that engine designers are compelled to depend mainly on empirical formulæ and the rule of thumb.

In the case of air screws, which work in a medium subject to great variations in pressure as well as temperature, the theoretical investigation is of course even more difficult. For this reason a series of experiments made during the past year by Professor Georg Welluer, of Brünn, Austria, is of considerable scientific interest apart from any special application to problems in aeronautics.

The following *résumé* of his investigations has been prepared from a paper read by the author before the Austrian Society of Engineers and Architects, and published in their transactions.*

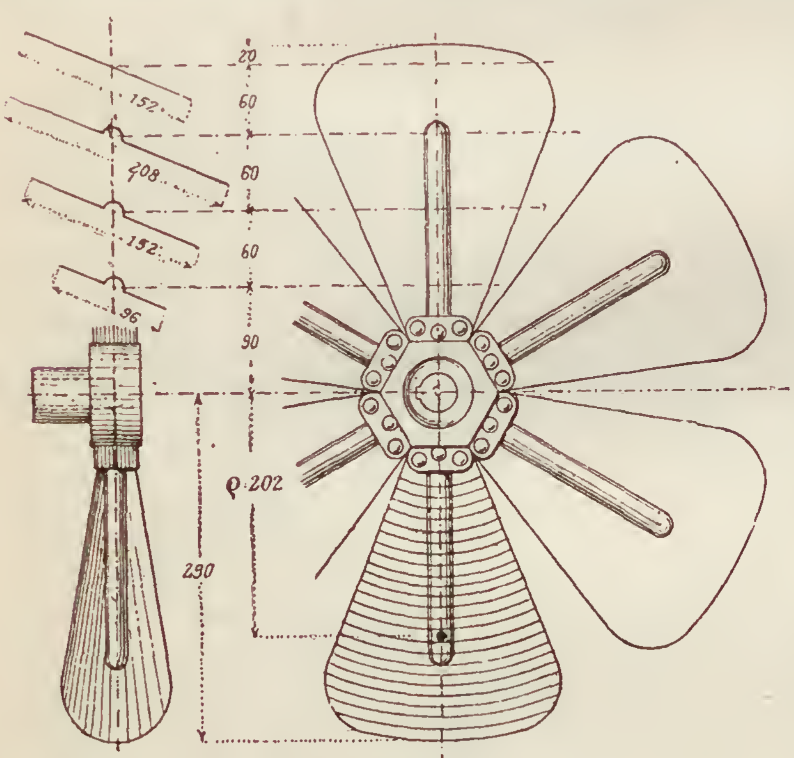


Fig. 1

The task the author had set himself was to determine for some half-dozen different forms of air screws the axial thrust exerted against the air and the amount of power required when the propellers revolve at different rates of speed.

His apparatus consisted of three parts :

1. A Siemens-Halske electric motor rated at ½ H.P. when making 1,500 revolutions per minute.

2. Air screws of different shapes and sizes, which could be readily attached to the shaft of the motor.

3. Devices for measuring the power absorbed in turning the screws as well as the actual thrust or reaction.

The various forms of propellers used are shown in figs. 1–6. For the purpose of comparing the different forms, the total projected area of the blades on a plane normal to the axis was in each case measured, and the reaction of the air was supposed to be concentrated at a distance from the axis equal to the radius of gyration.

These forms may be briefly described as follows :

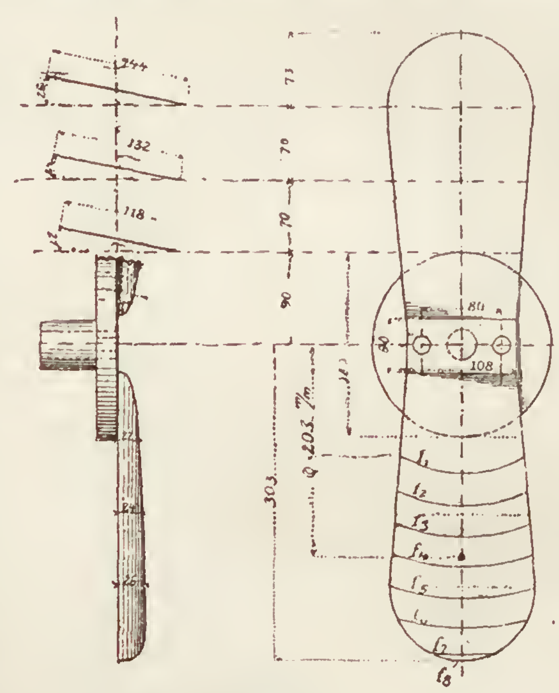


Fig. 2.

Fig. 1.—This is a six-bladed fan wheel built of sheet steel 1 millimetre in thickness. The blades are flat, inclined at 22½° to the normal plane, with a stiffening rib in each blade.

Its outside diameter = .580 metre (22.8 in.).

Its weight = 3.75 kilograms (8¼ lbs.).

The total area of the blades = .2124 square metre (2.286 sq. ft.).

The radius of gyration = .202 metre (7.99 in.).

Fig. 2. — The wheel consists of two small blades made of tinned plate. It weighs .340 kilogram (¾ lb.).

Its outside diameter = .606 metre (23.85 in.).

The blades are planes inclined at 10½°.

The total area of the blades = .05542 square metre (.596 sq. ft.).

The radius of gyration = .203 metre (8 in.).

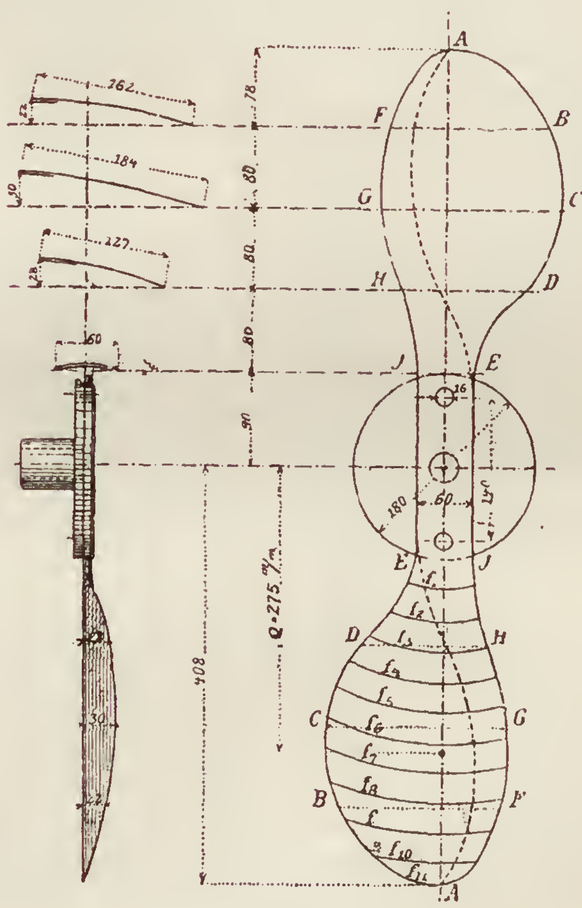


Fig. 3.

Fig. 3 is a spoon-shaped propeller built both with two blades (as shown in the drawing) and also with four. The shape is clearly indicated in the sketch, also the reinforced edges.

With two blades it weighs .70 kilogram (1½ lbs.).

The area of two blades = .085 square metre (.915 sq. ft.).

The outside diameter = .816 metre (32.12 in.).

The radius of gyration = .275 metre (10.83 in.).

* From the *Zeitschrift des Oesterr. Ingenieur und Architekten Vereins.* Vienna, August 17 and 24, 1894.

Fig. 4.—This drawing represents a "shovel-shaped" hollow warped surface, tapering to a point, with constantly decreasing curvature.

Its external diameter = 1.018 metres (40 in.).

Its total weight = .97 kilogram ($2\frac{1}{8}$ lbs.).

The area of the blades = .1223 square metre (1.316 sq. ft.).

The radius of gyration = .2997 metre (11.8 in.).

Fig. 5 is an S-shaped fan wheel, very slightly concave.

The area of the blades = .3322 square metre (3.57 sq. ft.).

The radius of gyration = .215 metre (8.46 in.).

Finally, fig. 6 shows a screw conforming closely to a true helicoidal surface of constant pitch. The central part is built up of two thicknesses of tinned plate, with stiffening angles. The angle of the blades varies from 9° to 45°, as shown by the cross sections.

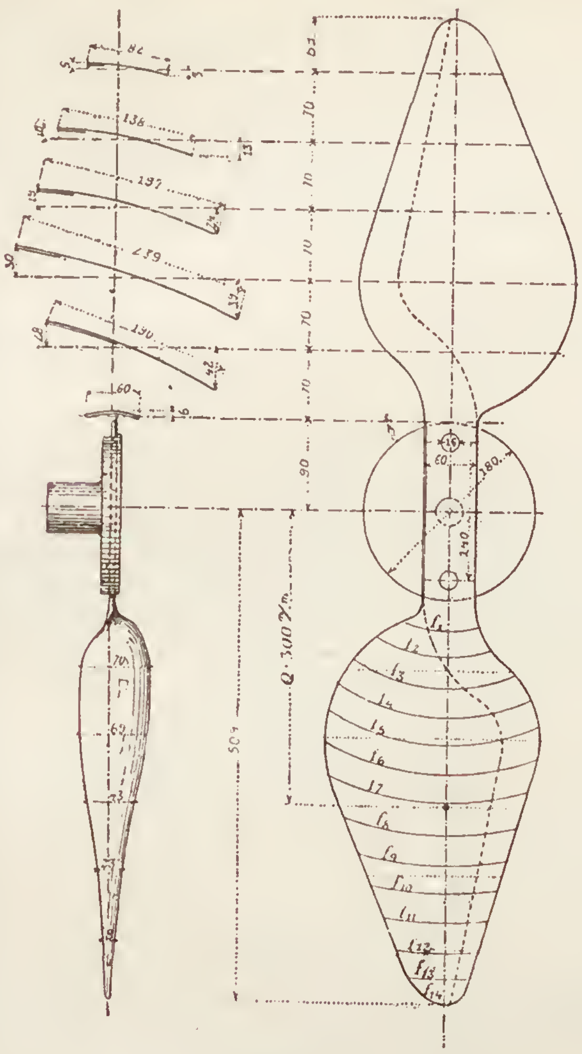


Fig. 4.

The external diameter = .980 metre (38.58 in.).

The total area of the blades = .089 square metre (.958 sq. ft.).

The radius of gyration = .3168 metre (12.47 in.).

The two methods used for measuring the thrust K are shown in figs. 7 and 8.

The *first method* consists in mounting the electric motor with the air screw attached on platform scales. The *upward* reaction produced by the screw when it is rotated can then be directly measured on the scale pan.

The *second* method (fig. 8) is less direct, but probably gives more reliable results than the first, as the action of the screw is not impeded by the proximity of other bodies. In this case the thrust K is held in equilibrium by the force of gravity, so that $K = Q\frac{s}{k}\,sin.\ \varphi$ where Q = total weight of the pendulum, and φ is the observed deflection angle for any given speed.

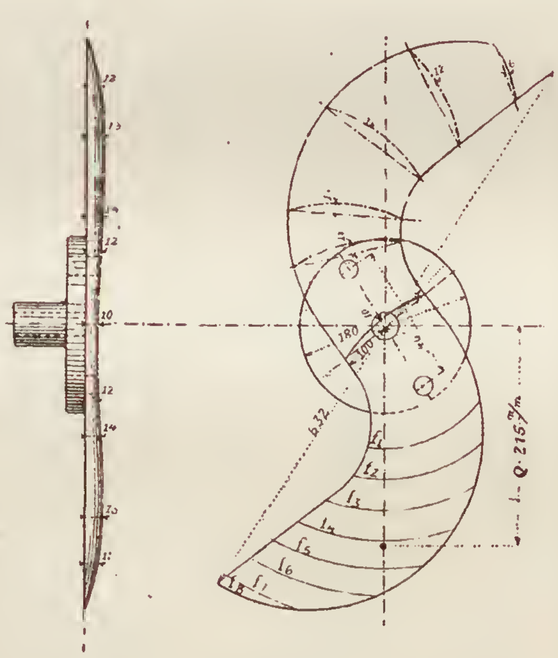


Fig. 5.

The power required to rotate the propellers was determined by electrical measurements. The motor (supported on the platform scales or suspended as a pendulum) was first run "light"—*i.e.*, without attaching a propeller, at speeds varying from 250 to 1,500 revolutions per minute.

Simultaneous observations were taken of the revolutions per minute, the current strength C and the electromotive force E. The resistance of the circuit R had been previously measured.

This gives us directly :

The total work done per second = $E\,C$ in watts.

The energy dissipated as heat = $R\,C^2$.

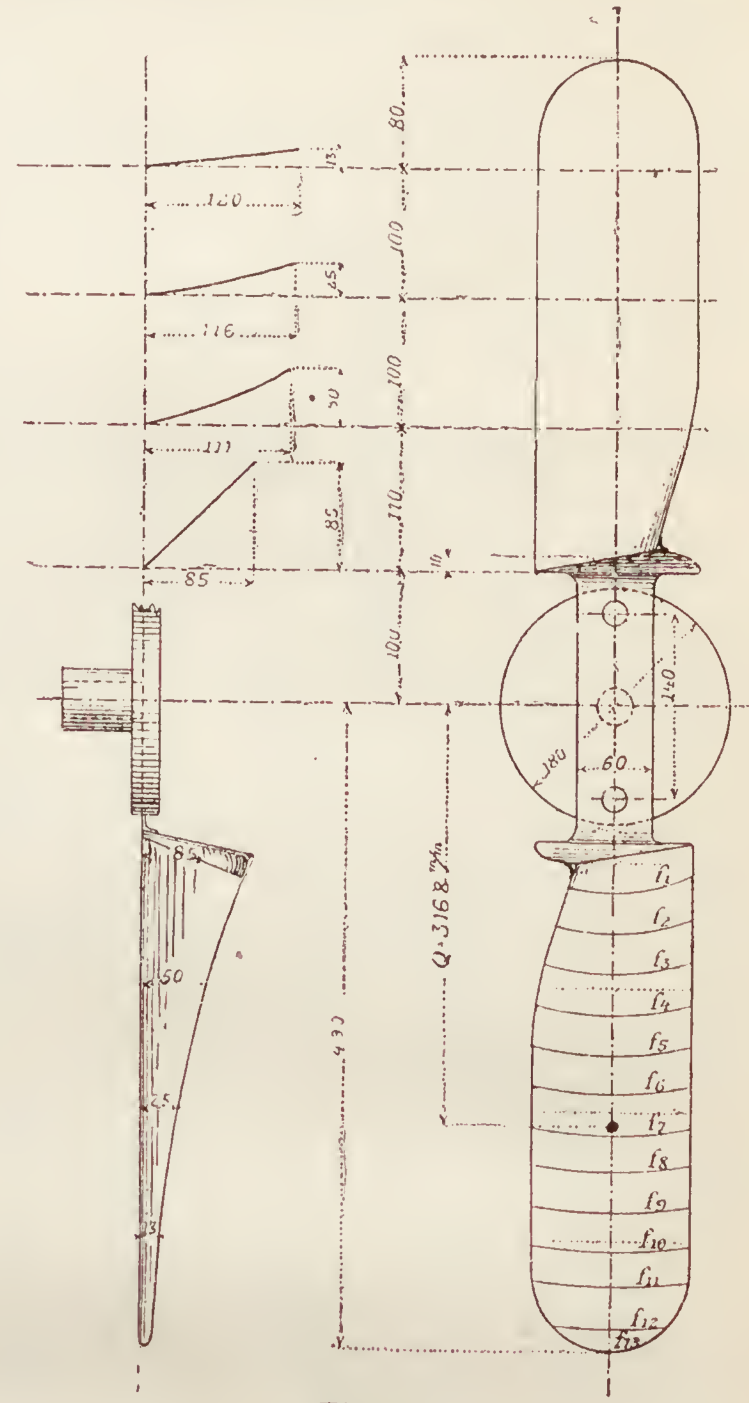


Fig. 6.

And finally, the *net amount of work expended per second in running the motor* = $E\,C - R\,C^2$.

After this the different forms of air screws were successively attached to the motor shaft, and a corresponding series of measurements made. From these last observations the *gross* amount of power required to run the motors, with propellers attached, was calculated by the formulæ given above.

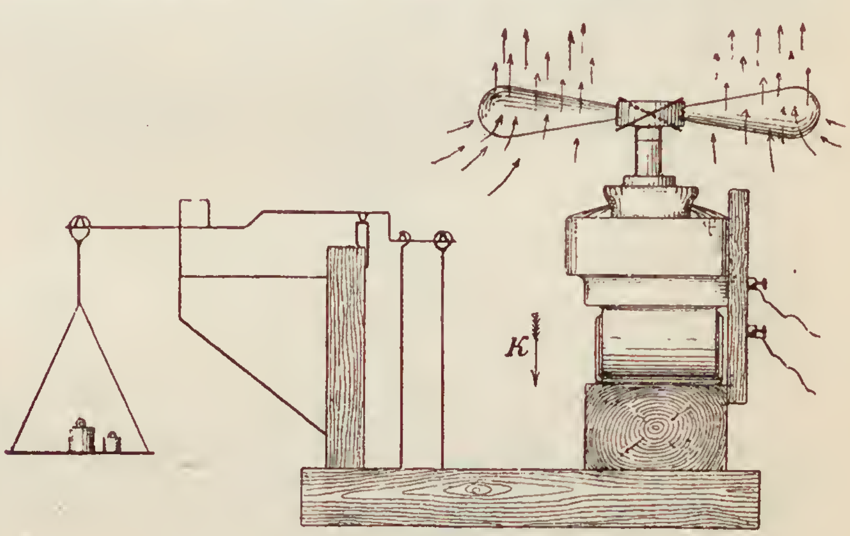


Fig 7.

The difference between these last values and the figures previously obtained when running the motors "light" at the same

speeds gave the net H.P. required for the propellers alone. At the same time the thrust K was measured for the same rates of speed. From these data a comparison of the efficiencies of different types was readily made.

A summary of the results obtained is given in the following table:

In this table

K = axial thrust in kilograms,

F = total area of propeller blades in square metres,

and

U = energy absorbed per second in metre kilograms,

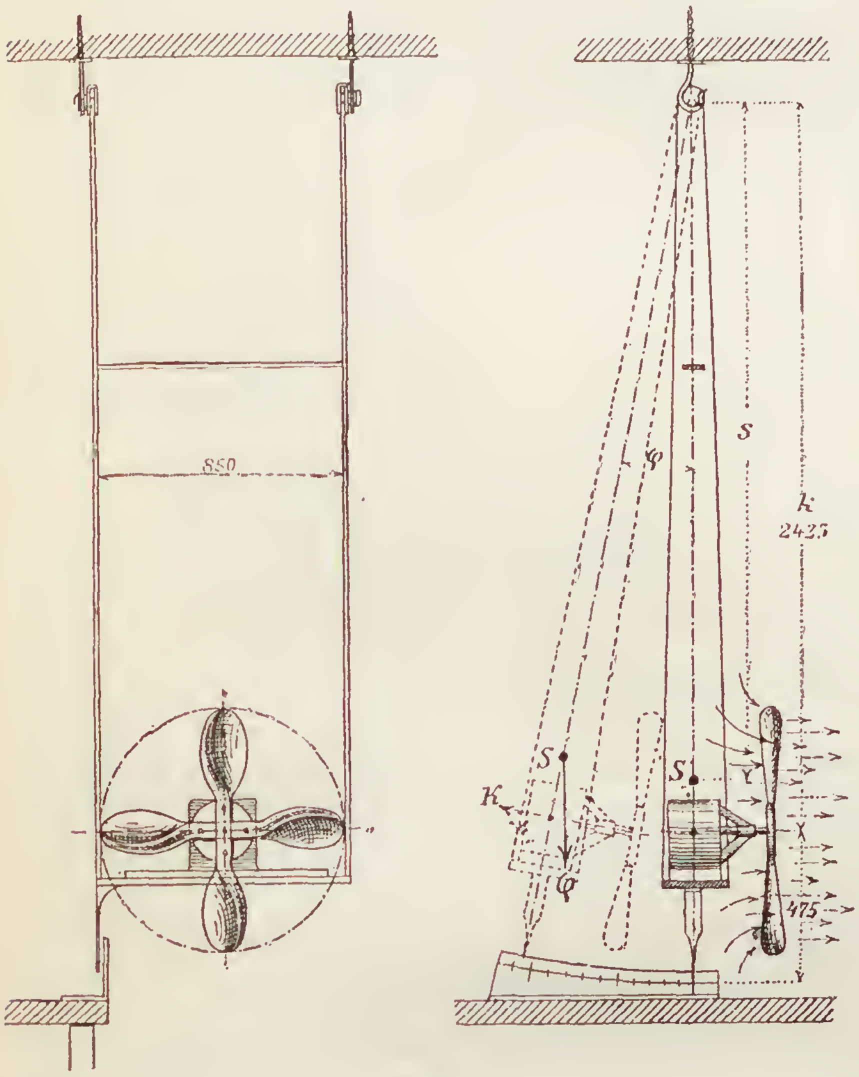


Fig. 8.

and the velocities given refer to the centre of gyration of each blade, or that point whose distance from the axis of revolution is equal to the radius of gyration.

TABLE I.

Velocity per Sec. of the Centre of Gyration.	Values of $\frac{K}{F}$, i.e., Axial Thrust in Kilograms Produced by 1 Square Metre of Blade Surface.				Values of $\frac{U}{K}$, i.e., Power in Meter Kilograms per Second Required to Produce 1 Kilogram of Axial Thrust.			
	5 m.	10 m.	15 m.	20 m.	5 m.	10 m.	15 m.	20 m.
Type 1	0.38	1.38	3.43	5.60	7.0	8.4	11.8	15.8
Type 2	0.33	1.32	3.01	5.18	4.5	6.0	7.1	8.2
Type 3—2 blades	0.49	1.90	4.29	7.40	5.2	5.4	5.6	7.3
Type 3—4 blades	0.36	1.25	3.06	5.61	3.3	3.8	5.6	6 6
Type 4	1.08	4.25	8.26	14.80	2.5	3.9	5.6	6.5
Type 5	0.04	0.15	0.34	0.60	15.0	25.0	38.0	60 0
Type 6	1.11	4.20	7.82	10.30	1.5	2.5	3.9	5.0

This table enables us to calculate the amount of thrust obtainable from propellers of different sizes by the expenditure of 1 H.P., and to see at a glance which are the most efficient shapes. We are also able to discard certain types tested as not suited to our purpose.

In the first place, we find that screws with only two blades give better results than those with four or six, and that narrow blades are more efficient proportionally than broad ones. This is probably due to the fact that there is less interference in the air currents from the several blades.

The outline in plan or shape of the blades is of no special importance, but the convex cutting edges probably tend to reduce air friction.

The high efficiencies obtained with types Nos. 3, 4 and 6 as compared with Nos. 1 and 2 show the great advantages of curved over flat blades. This is also clearly shown in the case of the S-shaped surface No. 5, which has an angle of inclination equal to zero, and is only slightly concave and still exerts an appreciable thrust, though of course not a large one. For this reason Professor Wellner recommends strongly the use of slightly hollowed blades with a versed sine of one-twelfth to one-twentieth of the chord length.

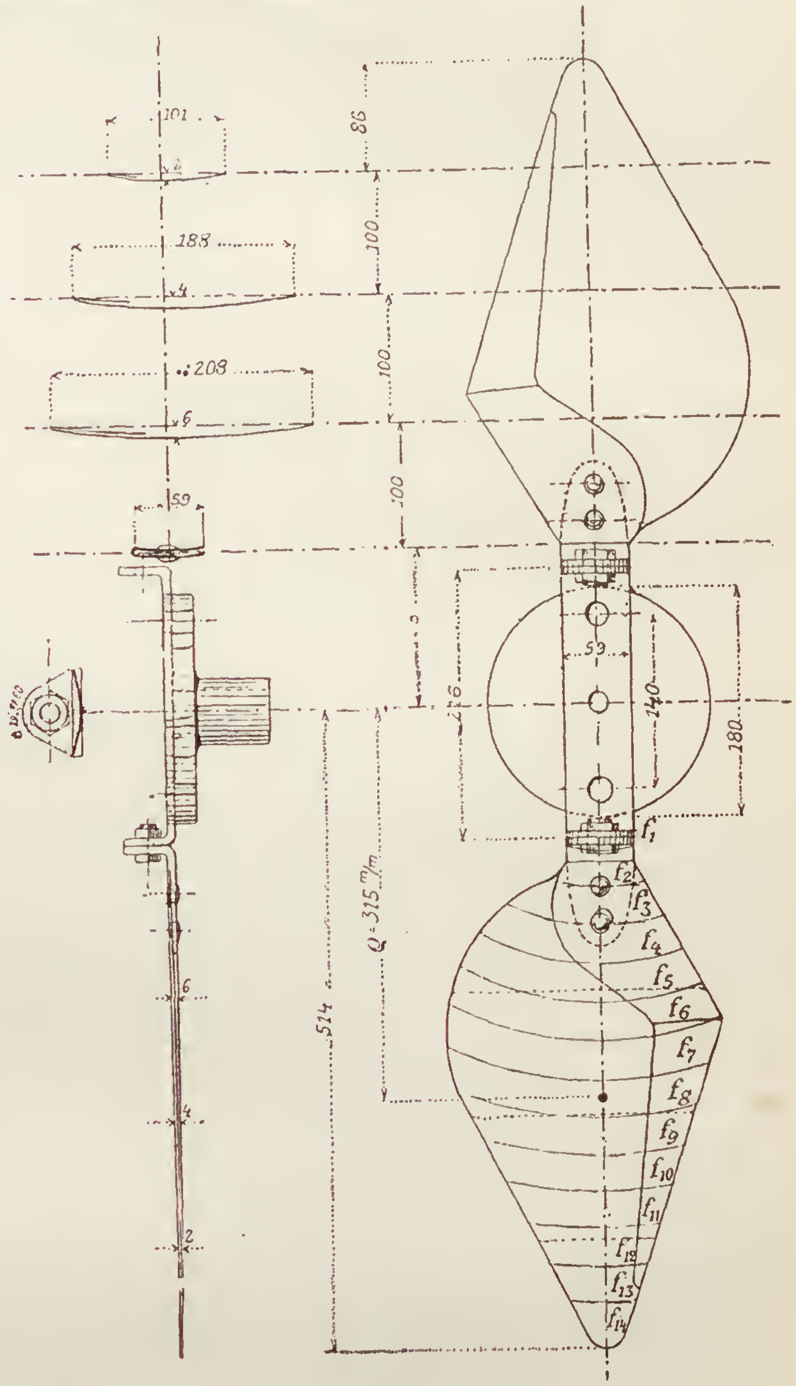


Fig. 9.

For aeronautical purposes screw propellers may be used horizontally to propel the car forward, or they may be mounted on a vertical shaft so that they will tend to lift the load. In the first case the reaction against the air K represents the propelling force, and in the second the direct "lift."

It is quite clear that the most powerful screw is the one which gives the greatest thrust for the smallest expenditure of work on the part of the prime mover, a consideration of even more than the ordinary importance in the case of machinery used in air ships.

All in all, the shovel-shaped propeller (fig. 4) and the true screw surface (fig. 6) give by far the best results at all speeds, as is seen at once by comparing the coefficients in the table. For example: For a velocity (of the centre of gyration of the blade) of 10 metres per second, type No. 4 requires only 3.9 metre kilograms per second in order to produce a thrust of 1 kilogram. Hence 1 H. P. (or 75 metre kilograms per second) would produce a thrust of $\frac{75}{3.9} = 19.23$ kilograms. The required blade area may be computed from the corresponding coefficients in the first half of the table.

In this case $F = \frac{19.23}{4.5}$, giving approximately 5 square metres for the total area of the blades.

Again, taking type No. 6 for the same speed, the thrust $= \frac{75}{2.5} = 30$ kilograms per H.P., and the corresponding blade area $= \frac{30}{4.2}$, or about 7 square metres.

These are clearly much better results than any of the other forms tabulated would give us.

Whether the numerical results obtained in these small scale experiments will hold good in the case of larger propellers is, of course, somewhat doubtful, and can only be determined by repeating the tests on a much larger scale.

The author contends that in any case those forms which give the best results in these small screws ought to be the ones selected for further experiments.

With this object in view he has supplemented his first series by some additional tests. In these he has used screws with blades almost perfectly plane, the slight convexity serving merely to stiffen the thin sheets.

Each blade was attached to the central plate by a small bolt, so as to be adjustable at any angle to the normal plane.

The object of these tests was to determine the thrust and required H.P. when the blades were set at different angles.

The screw used is shown in fig. 9, and the mechanism for applying the power and for measuring the speeds, etc., was practically the same as in the preceding series of experiments.

The screw as shown weighs 1.58 kilograms (3.48 lbs.).

Its diameter = 1.028 metres (40.47 in.).

The radius of gyration = .315 metre (12.4 in.).

The blade area = .1123 square metre (1.21 sq. ft.).

The blades were first set at an inclination of 5° to the normal plane, and then successively at 10°, 15°, 20°, 25° and 30°, and the corresponding values of K, of $\frac{K}{F}$ and $\frac{U}{F}$ were measured for different rates of speed by the method explained above.

The results are summarized in Table II., which corresponds in form to Table I., given above. In this table α = the angle of inclination, the other symbols having the same meaning as in Table I.

TABLE II.

Velocity per Sec. of the Centre of Gyration.	Values of $\frac{K}{F}$, *i.e.*, Axial Thrust in Kilograms Produced by 1 Square Meter of Blade Area.				Values of $\frac{U}{K}$, *i.e.*, Power in Metre Kilograms per Second Required to Produce 1 Kilogram of Axial Thrust.			
	5 m.	10 m.	15 m.	20 m.	5 m.	10 m.	15 m.	20 m.
$\alpha = 5°$	0.40	0.98	1.63	2.70	5.00	5.56	6.25	6.60
$\alpha = 10°$	0 90	2.05	4.78	6.66	2.02	2.42	3.75	4.70
$\alpha = 15°$	1.07	2.80	5.68	...	2.20	3.28	5.10	...
$\alpha = 20°$	1.16	3.07	6.94	....	2.30	3.77	5.51	....
$\alpha = 25°$	1.33	4.67	...	....	3.50	5.80	....	....
$\alpha = 30°$	1.65	6.01	..	....	4.87	7.26	...	....

An examination of this table indicates, as might have been expected, that the thrust K increases rapidly as the angle α gets larger. The values of $\frac{U}{K}$ in the second half of the table, however, show that this increased reaction is obtained by a much larger expenditure of energy when α exceeds 20°.

For this reason inclinations of from 10° to 20° give the most efficient screws. This result might also have been predicted on theoretical grounds.

The air pressure, which, of course, acts normally to the blade surface, may be divided into two components, one of which (K) is the thrust parallel to the axis of revolution, while the other acts at right angles to the axis. This latter component produces a pressure of the journal on its bearing which grows rapidly with an increase in α, and thus adds largely to the power required to overcome the frictional resistance.

For different rates of speed the thrust for any given angle of inclination ought theoretically to vary as the square of the speed of revolution, and the power expended as the cube.

In practice the friction of the air on the blades vitiates the calculations at least for small angles of from $\alpha = 0°$ to $\alpha = 10°$, though for inclinations between 10° and 30° the tests agree pretty closely with the results obtained from the mathematical theory.

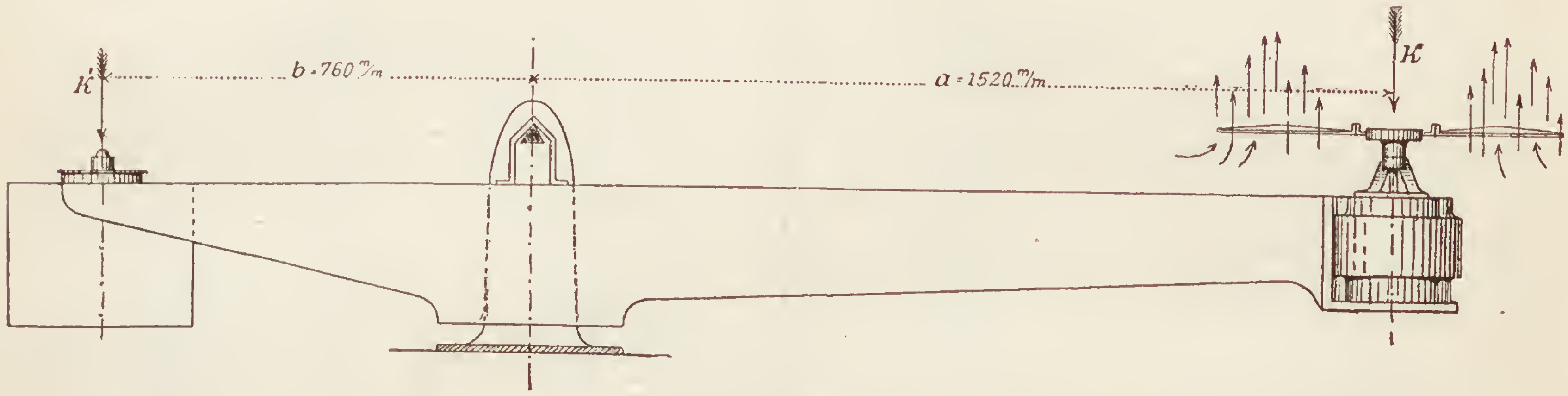


Fig. 10.

BALANCED LEVER METHOD OF WEIGHING POWER.

Hargrave's New Flying Machine.—We learn that Mr. Hargrave, of New South Wales, whose experiments with kites we illustrated last month, is now engaged in making the working drawings for a full-sized machine, to spread 480 sq. ft. of surface, to weigh 260 lbs., and to be driven by a 3 H.P. single screw. He expects to make a 10 minutes' run at first.

The Use of Captive Balloons at Sea.—The proceedings of the United States Naval Institute contain some interesting details which were communicated to the *France Aérienne* by Colonel Nicolas d'Orloff, concerning the search made from a captive balloon to try and discover the whereabouts of the ill-fated Russian warship *Rusalka*, which foundered with all hands in a storm in the Gulf of Finland. The transport *Samoyede* was fitted up to facilitate the ascent of the balloon. The expedition was under the charge of an officer and 25 soldiers of the aerostatic park of St. Petersburg. For 19 days the *Samoyede* was towed out from Helsingfors (Russia) every morning and towed back at night.

The balloon employed had a capacity of about 20,000 cub. ft.; it ascended to altitudes varying from 656 to 1,443 ft.; with a head wind it was towed at a rate of 2¼ knots; with a favorable wind the speed was sometimes increased to 6¾ knots per hour. Two observers were constantly in the car and were relieved every three hours. Glasses were not used, as it was found that the naked eye could discern objects at the bottom of the sea much better than when artificial aids were employed.

The conclusions arrived at were as follows: That at a height of 1,300 ft. it was not possible to see the bottom of the sea to any great depth, in consequence of the impediments to vision offered by the color of the water and of the bottom. With a favorable light, rocks and sand-banks were clearly defined at depths of from 19 to 23 ft. Larger sand-banks could be seen according to the color of the water at a depth of 40 ft.

Observations from a captive balloon are more easily carried out at sea than on land, because the air currents are more uniform and are not so subject to sudden changes. Vessels can be distinguished perfectly, and there is no difficulty in recognizing whether they are merchantmen or men-of-war. Colonel d'Orloff concludes that captive balloons would be of great utility as observatories to a fleet, enabling the officers to reconnoitre the entrance of unknown harbors, and for ascertaining the exact position of forts, batteries, and other defences. In time of peace the balloons could be used in hydrographical researches.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

Formerly the RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

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NEW YORK, JUNE, 1895.

EDITORIAL NOTES.

THE editor of the *American Machinist* has been conferring with "a prominent engineer," who says that a difficulty with a steam engine is to keep the cylinder hot, and, with a gas engine, to keep it cool. He therefore proposes to combine the two—the gas-engine cylinder to heat that of the steam engine, and the latter to cool the former. This recalls the scheme of an embryo civil engineer who observed that the top member of a suspension bridge was in tension, and that of a bow-string girder in compression. He therefore proposed a combination of the two principles, whereby the strains on the top member of the one would neutralize those on the other, and thus both could be dispensed with, and he would have a bridge with a lower chord alone. *That* bridge has never been built. How would it do to mix the exploded gases with the steam between the high and low-pressure cylinders of a compound engine?

ENGINEERING papers in this country are discussing the subject of standard sizes for publications, and various recommendations are being made. Thus far the Master Car-Builders' Association is the only one of the technical organizations which has taken action thereon. The sizes they have recommended are published in each number of the AMERICAN ENGINEER in our review department. No good reason is apparent why all, or at least most, books should not be made of standard size. To accomplish this, the publishers should be called into conference. It is being discussed in English papers as well as here, and evidently the subject is one of international interest and importance. Mr. Oberlin Smith recently, in a letter to the *American Machinist*, recommends that a 24 × 36-in. sheet of paper be taken as the basis of a system, and that its subdivisions into halves, quarters, eighths, etc., be adopted as the standards of size. This would give 24 × 36 in., 12 × 18 in., 9 × 12 in., 6 × 9 in., 4½ × 6 in., 3 × 4½ in., 2¼ × 3 in., 1½ × 2¼ in., and 1⅛ × 1½ in.

If the covers of books were made of these sizes their projection beyond the leaves would allow for trimming. The Librarians' Association would seem to be the parties to take the initiative in this matter so far as it relates to publishing business.

SOME time ago Captain H. Riall Sankey presented a paper at a meeting of the British Institution of Mechanical Engineers. This paper was then discussed, and at a more recent meeting the subject was reintroduced by the author of the paper. He then endeavored to show that, although for many purposes the popular verdict in favor of variable expansion governing may be accepted, yet its advantages are commonly much overrated, while in some cases it has no advantage whatsoever. A number of other members took part in the discussion, which revealed a great difference of opinion. Mr. Joy, the inventor of the valve-gear which bears his name, referred to the performance of some seven or eight locomotives running at from 50 to 52 miles an hour, the conditions in each case being even. Premiums were offered to those drivers who secured the best results. One set of men worked entirely on expansion—to the highest point of expansion; another set worked largely on throttling. The results came out almost identical. He believed that a judicious combination of the two methods, especially in electric-light engines, was to be preferred, and he anticipated that they derived the best results partly by throttle-valve and partly by expansion governing.

Professor Barr opined that the paper would afford a starting-point for many interesting experiments, stated that the right way to make trials was not to try an engine governed by a throttle-valve against a motor controlled by automatic expansion. The correct method was to take one engine and drive it neither with automatic expansion nor with throttling, but to drive it with a constant load upon the brake, and to make a series of experiments on the engine with the stop-valve throttle and the brake load adjusted accordingly.

COMPOUND LOCOMOTIVES.

IN another part of this number of the AMERICAN ENGINEER a report is published of the meeting of Mechanical Engineers, which was held on the evening of May 8, at which the subject for consideration was the much-disputed advantages and disadvantages of compound locomotives. Two very interesting papers were read, one by Mr. F. W. Dean, of Boston, and the other by Mr. C. H. Quereau, both of whom have had much experience with this class of locomotives. The authors of the papers and those who took part in the subsequent discussion —with the exception of one mechanical agnostic—were advocates of that kind of locomotives. As some one remarked, the meeting, to a very considerable extent, was a "compound love-feast." The proceedings and the arguments advanced revealed, though, what is very well known to all who have investigated the subject, that there is still a very great difference of opinion on this important subject among those who have the most abundant opportunities of getting information. The advantages and disadvantages of compound and simple locomotives were, however, set forth by the different writers and speakers in such a way as to permit of enumeration. This we will attempt to do, and will designate the various reasons for and against compound locomotives by letters, for convenience of later discussion. The advantages of compound locomotives as recited in the papers and discussion were as follows:

(*a*) Steam can be used more expansively.

(*b*) Higher steam pressure may be more advantageously utilized.

(*c*) Less wire-drawing of steam, because expansion is secured with a later cut-off.

(*d*) Cylinder condensation is diminished by reducing the range of temperature in the cylinders.

(*e*) Reheating of steam, and re-evaporation of its moisture by the waste gases is possible between the high and low-pressure cylinders.

(*f*) Steam which leaks through the piston and valve of the high-pressure cylinder is worked expansively in the second cylinder.

(*g*) Steam re-evaporated near the end of the high-pressure piston's stroke, too late to work expansively in a simple engine, is utilized in the low-pressure cylinder.

(*h*) Greater economy in the generation of steam, resulting from a lessened steam consumption, and consequent lower rate of evaporation.

(*i*) Reduced cost of boiler repairs, due to a lower rate of evaporation.

The disadvantages may be enumerated as follows:

(*m*) Back pressure on the high-pressure piston, which reduces the maximum rotative effect which can be exerted by a piston of a given size. That this is a disadvantage is shown by the fact that, in order that compound locomotives may be able to start and pull a maximum load, the compound principle must be abandoned temporarily, and such engines are worked by single expansion when they are required to exert their greatest power.

(*n*) Reduction of steam pressure in passing from the high to the low-pressure cylinders.

(*o*) Excessive compression in high-pressure cylinders.

(*p*) Greater heat radiating and absorbing surfaces in the cylinders.

(*q*) Increased weight of cylinders, pistons, intercepting valves, steam pipes, reheaters and their connections.

(*r*) Additional complexity in these parts.

(*s*) Greater weight of reciprocating parts with corresponding difficulty in balancing the engine, unless four cylinders are used, and their pistons are made to balance each other.

(*t*) In the case of two-cylinder engines, unequal pressure on the pistons on the two sides of the engine and consequent wear of wheel flanges on one side.

(*u*) Greater total first cost.

(*v*) According to Mr. Nichols, the "compound engine requires a great deal more care given to important details, and more attention in its repairs, in keeping in order, and probably considerably more expense than the simple engine."

(*w*) According to the same authority, "it requires a great deal more care and skill in running . . . and the simple engine requires less knowledge to understand."

Increased cost of repairs is also alleged for the compound engines; but that is a consequence of some of the above elements, and will not now be taken into account.

If, then, we could assign values to all these elements of advantage and disadvantage, obviously the solution of the problem would be very simple. Unfortunately this is not now possible, but it may facilitate an estimate of their value to consider them separately.

It may be stated as a rough but, for the present purpose, a sufficiently accurate estimate of the fuel expense of locomotives the country over, that they each burn about $2,500 worth of coal per year in those regions where coal does not cost more than from $1 to $1.50 per ton. If, now, we take Mr. Quereau's estimate of a saving of 15 per cent. under ordinary circumstances,

$$a + b + c + d + e + f + g + h + i = \$375,$$

and, according to Mr. Dean, the sum of these quantities is greater than $750. Of course these values would be increased in sections of the country where coal costs more than $1.50 per ton. But even if the estimates of annual saving are equal to these sums, we still must determine the value of

$$m + n + o + p + q + r + s + t + u + v + w.$$

If this exceeds $375 it will more than neutralize Mr. Quereau's estimated saving; and if the aggregate is more than $750, Mr. Dean's economy vanishes. While recognizing the great difference in the amount of saving attributed to the compound principle in locomotives by the authors of the two papers which were read at the meeting referred to, the correctness of their deduction will not now be questioned, excepting so far as they have been attributed to causes not included in that principle; the question which will be considered here is whether a saving of 15 or of 30 per cent. of fuel is sufficient to compensate for the disadvantages which have been enumerated.

The obviousness of the disadvantage designated by (*m*)—that is, the back pressure on the high-pressure piston—has perhaps blinded some and prevented them from recognizing its importance, just as we do not see the magnitude of an object which is held close to our eyes. To reduce the question to its simplest elements it will be supposed that the high-pressure cylinder on a two-cylinder compound locomotive is the same size as the cylinders of a simple engine, and that in starting steam is admitted during the full stroke of the piston; obviously if the exhaust discharges into a receiver of the same size as the high-pressure cylinder, the back pressure will be half that on the other side, and the tractive effort which can be exerted by that piston will be only half that which could be exerted by that piston if the steam was freely discharged into the atmosphere as it is by a simple engine. To get over this difficulty, one of three expedients must be adopted—higher steam pressure or high-pressure cylinders larger than those required for simple engines must be used, or, while the engine is exerting its maximum power, the compound principle must for the time being be abandoned. Obviously a simple engine can be made to exert its maximum power with greater facility than a compound engine can—a matter of great importance in a locomotive. Obviously, too, the conditions which exist with a marine or a stationary engine having a nearly constant load are very different from those prevailing in locomotive service, in which the power to be exerted varies from nothing to the maximum effort which the engine can exert.

(*n*) The reduction of steam pressure between the high and the low-pressure cylinders Mr. Dean says in some instances is 30 per cent, and in well designed engines only 8. In simple engines it is *nil*.

(*o*) Excessive compression in high-pressure cylinders is due to the fact that the enclosed steam has a greater tension on a compound engine than it has on a simple one, although the period of compression may be shorter in the one cylinder than it is in the other.

(*p*) The increase of heat radiating surface in the cylinders of a compound engine is an obvious consequence of their larger size. The same thing (*q*) is true of their weight. The latter increase would give a simple locomotive an obvious advantage, inasmuch as it would permit the excess of weight in cylinders, etc., to be put into the boiler or other parts of the simple engine. By this expedient the simple engine would have an advantage which is inherent in that system.

(*r*) The complexity of the compound engine, whatever it may be, obviously is to the extent to which it exists a disadvantage, the effect of which would be greater cost of repair and a diminution of service of the engine.

(*s*) The evil of increased weight of reciprocating parts now needs no comment, and so far no advocate of the compound system has claimed that they can be made as light for big cylinders as they can be for little ones.

(*t*) The unequal wear of flanges has been observed on some two-cylinder compounds. Whether the evil is inherent in that plan of an engine or a defect in the design of those on which it was observed there are perhaps now no certain means of knowing.

(*u*) The greater first cost of compound locomotives is a fact which cannot be ignored, and in no case has their cost been

reduced to that of a simple engine of corresponding capacity. The disadvantages designated by (*v*) and (*w*) are also important, and mean that more care and cost must be expended on compound than on simple engines. This represents money, and probably with a given amount of skill and expenditure such engines would not be in service as many days in a year as simple engines.

With reference to the advantages of reheating, which Mr. Dean has so skilfully applied to his compound engine, it is doubtful whether it can be claimed as an advantage of the compound system, as it is quite possible to superheat the steam of simple engines, and the results would be substantially the same. A reheater and a superheater are substantially the same thing. Doubtless the application of a feed-water heater would increase the economy of compound locomotives, but it would hardly be fair to claim whatever gain resulting therefrom for the compound system, as feed-water heaters may be just as advantageously applied to simple engines as to those of the compound type.

It is admitted, too, that many compound locomotives have been built which were badly designed, and that the system should not be judged by the failures, but by the successes. It would not be wise either to come to any final conclusions with reference to the relative advantages of the two types of engines from the experience of the past alone. It is but probable that in a new departure as radical as that which is involved in the construction of compound locomotives the highest degree of success should be reached with the first experience, and the failure of some badly designed locomotives built on this system is by no means conclusive. Evolution and development will be required here, as it is in all other advancement. But, on the other hand, it is folly to close our eyes to the difficulties which must be met, and it certainly would be unwise to delude ourselves by facts which are not true and arguments which are fallacies.

It is to be regretted, we think, that the committee on locomotive tests appointed by the Master Mechanics' Association laid out such an extended, pretentious and expensive plan as they did, and which involved the expenditure of a large amount of money, which it was impossible to obtain in the hard times which are behind us, and which are improving so slowly. A simple coal test would be possible on almost any road, which would throw light on this much-disputed subject, and which would not cost more than a few hundred dollars. Let the committee appointed to conduct the test select the best compound and the best simple engine of like class and weight, and arrange to haul trains on some road where there would be little likelihood of delays. Let them begin with a light load, and gradually increase it from day to day, and weigh the coal and trains accurately, being careful that the same quality of fuel is used on each engine. It would be important, of course, that the very best simple engine should be tested against the best compound; not, as has so often been the case, a good compound against a poor simple engine. The tests to be made under the general direction of the committee, they to employ a competent person to conduct them. It would interfere but little with the traffic of a road, and a few hundred dollars would cover the cost. The use of dynamometers, pyrometers, thermometers, calorimeters, revolution-counters, indicators, and other scientific instruments of high degree could be deferred until after the important fact was ascertained which engine was the most economical in coal. All that would be required would be to weigh it and weigh the trains and record the time, leaving other and more highly scientific observations for future tests. If the committee should have such a series of tests made, and make a clear and intelligent report thereon, and then indicate what further tests it would be profitable to make, probably there would then be no trouble in getting the money required; but it was not unnatural, when one roving compound committee applied to railroad companies for a sum as large as $15,000, to be expended by another similar committee whose measure of responsibility for the expenditure was not very definitely stated, it was but natural that the purse-strings of the railroad companies should be tightened and the committee turned away moneyless. What is wanted is a little money, a great deal of intelligence, and more light on this disputed question.

NEW PUBLICATIONS.

History of the Rensselaer Polytechnic Institute, 1824–94. By Palmer C. Ricketts. New York: John Wiley & Sons. 193 pp., $5\frac{3}{4} \times 8\frac{1}{2}$ in; $3.

The Rensselaer Polytechnic Institute, Mr. Ricketts tells us in his preface, was "the first school of science and the first school of civil engineering to be established in any English-speaking country. The history of this institution will therefore be of very great interest, especially to the many graduates of that school. The book before us has evidently been prepared with a great deal of care, is well printed in large, clear type, and quite fully illustrated with portraits of the founders and views of the inside and outside of the buildings, students at work, apparatus used, etc. A list of names of trustees, instructors and graduates, and a good index completes the volume.

Duty Trial of a Pumping Engine for the Louisville Water Company, Louisville, Ky. Built by the I. P. Morris Company; Owned and Conducted by the William Cramp & Sons' Ship & Engine Building Company. Philadelphia: 63 pp., $5\frac{3}{4} \times 9$ in.; 4 folded plates.

This pamphlet is a reprint of a report of a contract trial of engine No. 3, made by Dexter Brackett and F. W. Dean to the Louisville Water Company, and also two papers read by Mr. Dean before the American Society of Mechanical Engineers at their meeting last December. One of these was on a trial of the same Leavitt Pumping Engine at Louisville, Ky., and the other of a compound engine built by the Wheelock Engine Company, of Worcester, Mass., for Messrs. B. B. & R. Knight, of Providence, R. I. The discussion on the latter paper is also given. As these papers have been published in the Transactions of the society, an extended review is not called for. The report and papers are, however, put in convenient form for reading and reference, although some more satisfactory engravings of the Louisville engine would be most desirable.

The Slide-Rule: *A Practical Manual.* By Charles N. Pickworth. New York: D. Van Nostrand Company. 56 pp., 5×7 in.: 80 cents.

This little book is intended to explain the principles and uses of the Gravêt or Mannheim type of slide-rule, which has been in general use in Germany and France for a long time, although it is but little known to English-speaking engineers. Probably to most engineers and mechanics the slide-rule is a mystery; but if what those who understand how to use it say is true, it can be made a valuable adjunct of any engineer's equipment.

The slide-rule, the author says, "may be defined as an instrument for mechanically effecting calculations by logarithmic computation. By its aid various arithmetical, algebraical, and trigonometrical processes may be performed with ease and rapidity, the results obtained being sufficiently accurate for almost all practical requirements."

The principles and construction of the instrument are first described very concisely and clearly, and its application to the solution of various arithmetical and other mathematical problems is shown. Probably most persons who have never given the subject attention will be surprised at the variety of operations which can be performed with a slide-rule. Besides ordinary arithmetical calculations a number of problems in mensuration are given, which can be quickly solved by this means. A few examples of other problems will indicate the variety of uses to which it can be put. Among them are the following:

To find the weight in pounds per lineal foot of square bars of metal.

Set index B to weight of 12 cub. in. of the metal on A, and over the side of the square in inches on C read weight on pounds on A.

To find the centrifugal force of a revolving mass in pounds. Set 2,941 on B revolutions per minute on D; bring cursor to weight in pounds on B; index of B to cursor, and over radius in feet on B read centrifugal force in pounds on A.

Given the stroke and number of revolutions of an engine per minute, to find the piston speed.

Set stroke in inches on C to 6 on D, and over number of revolutions on D read piston speed in feet per minute on C.

The application of the slide-rule to the solution of problems relating to steam boilers, speed ratios of pulleys, etc., belts and ropes, spur wheels, screw cutting, strength of shafting, moments of inertia, hydraulics, electrical engineering, and a variety of trigonometrical calculations are described.

To our younger readers the book may be commended ; and it is evident that comparatively little study of it will give them an additional equipment which would materially add to their capacity for usefulness.

NYSTROM'S POCKETBOOK OF MECHANICS AND ENGINEERING. *Revised, Corrected and greatly Enlarged, with Addition of Original Matter.* By William Dennis Marks. Twenty-first Edition further Revised and Corrected by Robert Grimshaw. Philadelphia : J. B. Lippincott & Company. 675 pp. 4 × 6½ in.

As this is the twenty-first edition of this book, it may now be said to be of age. At any rate, a book which reaches a twenty-first edition must have merits which few books have. It is, however, about as difficult to point out these as it is to review a dictionary. One primary merit which it has is a good index, which, of course, is doubly essential in a book of this kind. In the printing of the book, however, the publishers, it is thought, have hardly maintained the high standard which usually characterizes their work. Take, as an example, page 34. The plate from which this was printed is decrepit, and the press-work would do discredit to a country office. Some of the engravings, too, ought to be replaced with new ones. In these days of cheap engraving there can be no sufficient excuse to use ancient illustrations in a book of this kind. It may also be remarked that the locomotives and cars illustrated on page 157 are superannuated.

Probably there is no part of a book of this kind which the users of it will refer to oftener than to the tables of circumferences and areas of circles. These tables in the book before us are combined in one. In most other similar books the circumferences and areas are given in separate tables. The columns of circumferences are headed with a circle, the inside area of which is unshaded, while the columns of areas have circles at the top which are shaded. A glance at the heading thus indicates at once whether the column contains the circumferences or areas of circles, and thus prevents errors, which have sometimes been productive of serious results. The whole book is very conveniently arranged for reference, and doubtless many to whom "Nystrom" has been a constant companion for many years will welcome this volume in a new dress.

THE SCREW PROPELLER AND MARINE PROPULSION. By I. McKim Chase, M.E. New York : John Wiley & Sons, 53 East Tenth Street. 8vo, cloth, pp. 223, $3.

It is refreshing to a marine engineer of the old school to open the pages of this book and find these important subjects of his profession clearly and conclusively treated, without the use of fatiguing formulæ of the higher mathematics that are so formidable an obstacle to the class of students to whom this book will be of most value.

The author has had a wide experience in the laying out and construction of screws, and he gives to the reader the results of this experience in a manner as plain and practical as the conventional pike-staff. He carries his subjects far beyond this, however, and discusses thoroughly the principles that underlie the action of the screw.

He ventures into no speculations based on theories, but gives a very complete *résumé* of the conclusions of the best reasoners on the subjects of which he treats. In the preface to his second volume, Isherwood says : "The whole science of engineering rests simply on direct facts."

In no part of marine engineering is this more true than of the screw propeller. All improvement in the efficiency of this instrument has been brought about by processes purely tentative ; it has been a long succession of trying, of essaying.

Our author agrees in this when he says : "The best that can be done is to observe the practical results of screws in actual operation, and to follow the dimensions of those which give the best results under the nearest conditions to those to which the one under consideration is to be subjected." These remarks, however, need not be understood as denying "the utility of well-framed hypotheses, which is very great when they are applied with sagacity and controlled by caution." But well-digested data seems to be the only sure guide in the designs of screws ; and unquestionably a very large majority of those in use were absolutely so designed. This should not deter the student from a study of principles ; a knowledge of them will enable him to arrive at sound conclusions from collected data, and prevent his ploughing in over-garnered fields, which have never grown anything but weeds. The author gives the results of performance of the screws of a large number of naval vessels, going as far back as the case of the *Iris* (whose vagaries of performance puzzled the engineers of her day), down to those of the ships of our new navy, of which there is very accurate and reliable record. Of the screws thus referred to, full detailed drawings are given, as well as of many others.

The elements constituting the chief resistance encountered in ship propulsion are discussed in a clear and simple manner, to which easily comprehended illustrations add lucidity. The peculiarities of jet propulsion are plainly set forth, and its limitations demonstrated.

Some of the other subjects treated are : Screws of Various Character ; Drawings of Screw Propellers and their Construction ; Stream Lines ; the Position of the Screw ; Causes of Vibration ; Material best Suited for Blades, etc. In the appendix much valuable information is given.

We believe we risk nothing in asserting that this is the best practical work on the screw and the conditions that affect its action ever published. It will be a great aid to the student in marine engineering, whether he is storing up knowledge in a technical school, or in his own way after his day's work is over. It is well printed on good paper, substantially bound, and all the illustrations are clear and easily understood. The young reader should be cautioned against an error which has converted "stream lines" into "steam lines."

A MANUAL OF INSTRUCTION FOR THE ECONOMICAL MANAGEMENT OF LOCOMOTIVES, FOR LOCOMOTIVE ENGINEERS AND FIREMEN. By George H. Baker. Chicago and New York : Rand, McNally & Co. 116 pp., 4½ × 6½ in.

In his introduction the author of this little manual says its object is "to properly instruct engineers and firemen in the economical management of the engines and use of fuel." It belongs to that class of literature which the authors like to call "practical," and which usually has some marked characteristics.

It cannot be said usually that one of these is the clear exposition of scientific principles. Therefore the value of such books is seldom found in that department, but generally in the directions which give the writers' experience in doing things which they have been accustomed to do. The little volume before us is an illustration of this. The chapters on Heat and Combustion can hardly be regarded as models of lucidity or of very complete explanations of the scientific principles relating to these subjects, but probably few engineers and firemen could read the directions for the management of fires and running locomotives without being benefited thereby.

The book has only a few illustrations, whereas it ought to have many, as the graphic form of instruction is generally more effective than that which is merely verbal. The engraving on the cover is an illustration of this, which gives views of a lump of coal, actual size, weighing a quarter of a pound. This, it is said, represents the quantity of coal which is *usually wasted per second* when steam is blowing off from the safety-valve. If a mischievous boy was sitting on a tender and throwing off lumps of coal of this size at the rate of one per second, probably most observers would feel like kicking him. Those who are made to realize the waste from blowing off steam will perhaps feel a similar inclination to kick the fireman when the safety-valve of his engine opens, although it might not be so safe to gratify that inclination in the case of the fireman as it would be on a boy.

The book is without an index, which, in New England parlance, "hadn't ought to be."

THE STEAM ENGINE AND OTHER HEAT ENGINES. By J. A. Ewing, M.A., Professor of Mechanism and Applied Mechanics in the University of Cambridge. New York : Macmillan & Co. $3.75.

Some years ago Professor Ewing prepared the article on the Steam Engine for the *Encyclopædia Britannica ;* now he presents this excellent book which has been developed from the material then prepared. The book is naturally much more expanded than the encyclopædia article, and has, of course, been written entirely anew. It retains the combination of clearness and compactness found in the original article, together with a thoroughly sound treatment of the subject. In just 400 pages, including tables and index, there is given a discussion of the thermodynamics of air and saturated steam ; the theory of the steam engine, the hot-air engine and the gas engine ; the action of steam in the actual engine ; the effects of superheating, jacketing and compounding ; methods of test-

ing and tests on the steam engine; valve gears, governors, and the action of reciprocating parts; steam boilers; and forms of steam engines.

Of course something must be sacrificed in so compact a treatment of so many subjects on which many entire books have been written, but the choice of methods and the proportioning of space are met so as to give a complete and well-balanced whole. Adverse criticism of details must be in the main an expression of a difference of opinion. One may, for example, question the necessity of an introductory history of the steam engine taking some 30 pages of the volume.

The treatment of the thermodynamics is simplified by confining it to air and saturated steam, by accepting the scale of the air thermometer at the outset, by assuming the internal energy of a gas to depend on the temperature only, and by a special treatment of the specific volume of superheated steam. All these devices are legitimate; the only effect is to narrow the work; but that is the effect desired.

The author accepts Rowland's determination of the mechanical equivalent of heat, namely, 778 instead of the conventional 772, from Joule's earlier determinations. He does not accept Rowland's determination of the specific heat of water—an inconsistency that is not uncommon with writers on thermodynamics. Considerable use is made of the temperature-entropy diagram, which deserves more attention than has been given to it in America.

The author gives a judicious statement of the present state of our knowledge of the behavior of steam in the cylinder of an engine and the effects of superheating, jacketing and compounding. The plain slide-valve easily receives a brief and yet a complete treatment; more complicated gears like link motions and radial valve gears are explained only in a general manner. The discussion of governors gives a correct idea of the principles and the action of several types. A very elegant treatment is given of the dynamic effect due to the reciprocation of the piston and the parts moving with it. The action of the connecting-rod is, however, considered too complex for more than a general treatment.

It is to be regretted that the chapter on boilers does not give a better discussion of fuels and combustion—subjects which are at once important and susceptible of a clear and brief treatment. The author, however, considers the boiler only as an adjunct, and not improperly confines his work to a description of a few typical forms.

The book is completed by a chapter on the forms of steam engines, including the steam turbine, and a chapter on gas and oil engines.

Indicator Diagrams and Engine and Boiler Testing. By Charles Day, of the National Boiler Insurance Company, Manchester, England. Manchester, England: The Technical Publishing Company, Limited. 205 pp., $4\frac{3}{4} \times 7\frac{1}{4}$ in.

To a reviewer an author's preface usually indicates the aim he had in mind when he wrote his book. In the present instance the writer of the book before us says that "the purpose of the first portion is to explain the construction of different kinds of indicators used, and show their advantages and disadvantages, also to explain clearly the general principles on which the interpretation of indicator diagrams is based."

The second portion of the book relates to the Testing of Engines and Boilers, the information relating to which is scattered very widely, and in some cases is difficult of access. The author has, therefore, aimed to give very explicit and full directions for making such tests, which he modestly says he hopes will be of service to engineers who have not had previous experience in this direction. It may be said that he has succeeded admirably in what he has aimed to accomplish, and has given to engineers a book of very great value. It is not written either in that enigmatical style which, unfortunately, is so common in many technical books of the present day, but everything is explained with the utmost clearness, and the writer has not felt—or if he has, he has resisted—the temptation to display his knowledge of mathematics. The whole book is delightfully clear, and the reader soon acquires the feeling that the author is describing what he has actually done, and not merely what he has been reading or speculating about.

The first chapter is on the Development of the Indicator, which contains a brief sketch of its beginning, with Watts' invention, and goes on to describe the instruments which have since been and are now made by different manufacturers. These are illustrated with very clear engravings, showing the construction of the different instruments, and their respective defects and advantages are pointed out.

The second chapter is on Reducing Gears for Indicating, and describes the various methods of reducing the motion of the engine piston and imparting a coincident movement to the indicator card. Various methods of attachment of cords, levers, pipes, and cocks are described with critical remarks, pointing out their good and imperfect features.

Chapter III is on the Forms of Indicator Diagrams, and gives an admirably clear exposition of how an indicator diagram is made and how its form is produced by the varying pressure in the cylinder, and thus reveals the tension of the steam in the cylinder during the whole period of the stroke of the piston. The relation which the pressure on the piston should bear to its acceleration and retardation is also explained, although perhaps not as fully as the complexity and the importance of the subject demand.

Chapter IV is on Steam-Engine Valves and their Influence on Indicator Diagrams.

Chapters V, VI and VII are on Defective Indicator Diagrams, which most experienced engineers will find very interesting. Their interest, too, will be increased by the remark in the preface that "the illustrations are exact reproductions to a smaller scale of diagrams actually taken." A large number of such diagrams are given, having all kinds of distortions, and illustrating a great variety of defects, which are explained so clearly that the acquisition of an understanding of them is a pleasure instead of being reached only through much mental travail, as is so often the case on reading literature belonging to this class.

Chapter VIII is on Multiple-Expansion Engines, and describes the method of taking and combining the indicator diagrams.

The second part of the book is on Testing of Engines and Boilers, the greater portion of it being devoted to the latter. In making such tests, the author gives the following list of the principal observations which should be made:

(*a*) Measurement of coal and ashes, and collection of coal samples.

(*b*) Measurement of water.

(*c*) Pressure in boiler.

(*d*) Height of water in boiler.

(*e*) Temperatures of feed-water, air entering furnaces, and gases leaving boiler; also temperature in furnaces if possible.

(*f*) Analysis of coal.

(*g*) Collection of samples of flue gases and analysis of same.

(*h*) Testing dryness of steam.

(*i*) Height of barometer and state of weather.

The method of making and recording these observations, and the apparatus required is then fully described and illustrated. In no other publication will the reader find this information so fully and clearly elucidated. For the purpose of measuring water a system of tanks is illustrated, which will be a great help to any one undertaking such work.

Some simple methods of analyzing coal are also given, which may be used by a person with little or no chemical knowledge, although the author recommends that a chemist be employed for such work.

The directions for the collection of samples of flue gases, and the analysis of them, and the illustrations and description of the apparatus to be employed are also excellent. For testing the dryness of steam, a variety of calorimetres are shown and explained, and their relative advantages and defects pointed out.

In but one instance has the author failed to explain the subject treated of so as to leave the reader in a state of foggy ignorance. On page 158 he refers to the use of the "economizer," which, he says, "we will assume to be of the ordinary Green's type." Unfortunately many of his readers in this country have only vague ideas of what he means by an "economizer," and hardly any know what Green's type is. An engraving of it, with a brief explanation, would have helped American readers materially.

Of the observations to be made in testing engines he gives the following partial list, which he says may be extended or curtailed to suit the circumstances of each case:

(*a*) Indication.

(*b*) Counting of speed.

(*c*) Reading of various pressure and vacuum gauges.

(*d*) Temperature of injection and hot well water.

(*e*) Measurement of water leaving all cylinder and jacket drains, and leaking at any joints or glands.

(*f*) Determination of frictional resistances.

Brief descriptions of the methods of making all these observations are given.

The last chapter is on the calorific value of coal, which is followed by several appendices, one giving blank forms for balance sheets of boiler and economizer, and another a list of the principal results which can be determined from the observations described in the book. This is followed by an elaborate table of "piston constants" for determining the I.H.P. per pound of mean pressure on piston, which will be

found very convenient if the horse-powers of different kinds of engines must often be determined.

The book can be highly commended, as it is altogether the best book on the indicator and on engine and boiler-testing that has thus far been published. It is fairly well printed, and while the illustrations are not of superlative excellence, they are all very clear, and serve their purpose, perhaps, as well as they would if their artistic execution was better.

MOTIVE POWERS AND THEIR PRACTICAL SELECTION. By Reginald Bolton. New York: Longmans, Green & Co. 257 pp., 5 × 7½ in.

The problem of the selection of a motive power suited to certain conditions is often a matter of great perplexity to those who have little or no technical knowledge of the elements which should determine what kind of motive power should be used. In his introduction the author says that "it has appeared to him that a compilation or a condensation of the facts that go to settle these questions in the hands of an expert would prove of wide value not only to his class, but may be made sufficiently simple to be of a practical use in those numerous cases where these questions have to be solved by those on the spot without technical aid." He says, further, that he has, therefore, aimed, in writing the book under review, "with the double purpose of condensing and arranging these facts and figures for the easy reference of engineers and for the ready comprehension of the non-technical."

The method which he has adopted may be described by a brief review of the chapters on steam boilers. He begins by classifying them into internally and externally fired boilers. He then gives an excellent dissertation on the "power of boilers," and points out that it is "indicated by their capacity in pounds of water turned into steam per hour." He then explains that to evaporate a given amount of water in a given time a certain amount of grate area is required to burn the requisite amount of fuel, and so many square feet of heating surface are required to absorb the heat developed by the combustion of the fuel. He also points out that steam raised in a boiler may be economically or wastefully employed, and that an identical boiler with a poor engine may be ratable at an entirely different H.P. to what it would be when working in conjunction with a better motor. He then enumerates different classes of engines whose consumption of steam varies from 40 to 15 lbs. of steam per H.P. per hour. The amount of grate surface and heating surface required in different classes of boilers per pound of water evaporated per hour is then given, and is as follows:

	Grate, Square Feet.	Heating Surface, Square Feet.
Lancashire boilers	.008	.234
Cornish "	.014	.33
Locomotive type boilers	.0071	.15
Externally fired tubular boilers	.008	.266
Marine or Scotch boilers	.006	.222
Water-tube "	.008	.25

It is then explained that to ascertain how much grate and heating surface will be needed for a given engine, we must know its H.P. and the quantity of water which it consumes per H.P. per hour, and by multiplying these and the figures given above we will have the grate area and heating surface required in any of the types of boiler enumerated, and for an engine whose rate of water or steam consumption is known. A table is constructed from these data for different types of boilers and engines, from which the amount of grate and heating surface can be readily ascertained. Some formulæ relating to the proportions of boilers and a statement of "essentials for good boiler work" are given. This is succeeded by some short chapters on the different types and costs of boilers. All through the book very full information concerning the cost of the various kinds of plant described is given. In fact, fully as much commercial as engineering information is given.

The book is subdivided into short chapters, which contain discussions and data concerning Manual, Animal, Wind and Water Power; Water-wheels; Tidal Action; Floating Mills and Water-wheels; the Pelton Wheel; Turbines; Steam Power; Boilers; the Power of the Expansion of Gases; Oil Engines; Vapor or Gasoline and Hot-air Engines; the Storage of Power by Electricity and Re-use of Same; and Shafting and Belting.

To a very great extent the data given is reduced to tabular forms, which adds greatly to its convenience for use.

For persons called upon to decide what kind of power should be used under given conditions, and to engineers generally, the book will be very useful, as the information which it contains—and there is a great deal of it—can nowhere be found in so condensed a form.

BOOKS RECEIVED.

OPERATIONS OF THE DIVISION OF MILITARY ENGINEERING OF THE INTERNATIONAL CONGRESS OF ENGINEERS, held in Chicago last August, under the auspices of the World's Congress Auxiliary of the Columbian Exposition. 982 pp., 5¾ × 9 in. Washington: Government Printing Office.

THE MECHANICAL ENGINEERS' POCKET-BOOK. A Reference-Book of Rules, Tables, Data, and Formulæ, for the Use of Engineers, Mechanics, and Students. By William Kent. 1,087 pp., 4 × 6½ in. New York: John Wiley & Sons.

SOUVENIR BROTHERHOOD OF RAILROAD TRAINMEN. Galesburg, Ill. 20 pp., 6 × 9 in.

This is a highly ornate publication, which gives a history of the brotherhood and its work, portraits of its officers, views internal and external of its headquarters in Galesburg, description of its journal, etc. It will interest the members of the brotherhood and their friends generally.

TRADE CATALOGUES.

IN 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. The advantages of conforming to these sizes have been recognized, not only by railroad men, but outside of railroad circles, and many engineers make a practice of immediately consigning to the waste-basket all catalogues that do not come within a very narrow margin of these standard sizes. They are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

IT seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.

STANDARDS:

For postal-card circulars	3¾ in. × 6½ in.
Pamphlets and trade catalogues	3½ in. × 6 in.
	6 in. × 9 in.
	9 in. × 12 in.
Specifications and letter paper	8½ in. × 10¾ in.

CRAWLEY COMBINED STEAM JACKET, FEED-WATER HEATER FILTER, PURIFIER, OIL EXTRACTOR AND CONDENSER. Manufactured by the Milwaukee Boiler Company, Milwaukee, Wis. 12 pp., 3½ × 6 in. [Standard size.]

This little publication describes the Crawley feed-water heater, which is illustrated by a sectional view on the first page, and is described and its merits set forth on the pages which follow.

UNION GREASE COMPANY. Manufacturers of Lubricants for Steam and Electric Railroads and Steamships and all Heavy Machinery. Boston, Mass. 16 pp., 6 × 9 in. [Standard size.]

The merits of grease have probably been the subject of more trade eloquence than any other article which commercial men have to sell. It is, therefore, with a little surprise that one finds a pamphlet devoted to the exposition of the merits of a noted article of this kind; is written in a very temperate key which inspires confidence by its modesty. The characteristics of the grease manufactured by this company are set forth, directions for its use are given, and interior views of the works, showing the methods of its manufacture, are given, and the pamphlet ends with testimonials and a list of the users of the lubricant.

THE STERLING GASOLINE TRACTION AND PORTABLE ENGINES. Manufactured by the Charter Gas Engine Company, Sterling, Ill. 8 pp., 5¼ × 6¾ in. [Not standard size.]

The use of gasoline for traction engines is comparatively new, nevertheless the Charter Gas Engine Company have evidently devoted a great deal of skill and time to the designs of the traction and portable engines which are illustrated by excellent woodcuts in the circular before us. The description of these admirable machines seems to be too meagre to satisfy the mind of an engineer who is athirst for information about

them. The engravings, too—which are admirable—have hardly had justice done to them in the printing. They show plainly that the engines were designed by a master of the art, and the testimonials sent with the circular referred to will be weighty evidence of their efficiency.

Sketches of Wonderland Penetrated by the Northern Pacific Railroad. By Olin D. Wheeler. Northern Pacific Railroad, St. Paul, Minn. 108 pp., 6¾ × 9⅜ in. [Not standard size.]

There seems to be hardly any limit to the cost and elaborateness of the guide-books which railroad companies find it to their interest to issue. The one before us gives a very complete description of the country traversed by the Northern Pacific Railroad, and many very interesting views of the wonderful scenery along its line. It begins with St. Paul and Minneapolis, the main eastern termini of the line. A description is then given of the Lake Park region of Minnesota, with views in the Detroit Lake region. The Red River Valley, the Rocky Mountains, and their vicinity are described, with a number of excellent views. This chapter is followed by a description of the Yellowstone Park, which is also fully illustrated with views of the wonderful geysers, mountains, places and characteristics of the scenery along the line of the road. An excellent map of this region will also enable the traveller to know "where he is at." After this comes a description of Mount Rainier, and an account of its ascent by a Northern Pacific party. Many excellent views of the mountain and places in its vicinity accompany the description.

Among the other admirable engravings is one general view of Portland, Ore., with buildings in and scenes near it. The closing chapter is on Alaska, and it ends with a map of the line of the road. The mechanical work of the book is in every way excellent.

"Elephant Brand" Phosphor-bronze and other Alloys, *their Qualities and Applications.* The Phosphor-Bronze Smelting Company, Limited, Philadelphia, Pa. 19 pp. 4 × 6 in. [Not standard size.]

In their little pamphlet the publishers have set forth the nature, qualities, and uses of phosphor-bronze, of which they are the original manufacturers in the United States. The different qualities of the metal which the company make are designated by letters, and the following is a list of their uses :

Quality.	Application.
A.	For parts of machinery subject to constant vibration. Very tough.
B.	For general machine casting : pinions, cog wheels, trolley wheels, propeller screws, hydraulic press and pump work, piston-rods, screw bolts for steam cylinders and hardware. Very tough and hard, and especially recommended to resist crystallization and corrosion.
C.	For valves, cocks, cylinder linings, etc. Hard and durable in resistance to wear and corrosion.
D.	For valves, pumps, plungers, slides, steps, etc. Nearly as hard as steel.
E.	For bearings of heated rolls, valves, etc. Very hard.
F.	For bells, steam whistles, etc. Harder and stronger than ordinary bell metal.
G.	For rods and bolts. Very tough.
S.	Bearing metal for all bearings of locomotive, marine and stationary engines, passenger, freight and street cars ; roll neck bearings, thrust rings, slide valves, cross-head gibs, piston rings, etc. Very hard and durable, and not liable to heat nor cut the journal.

The elephant comes in as a trade-mark ; and while there is every reason for believing that the metal is excellent, the beast needs improving. The public probably have no right to ask for any better metal than this company makes, but it would be perfectly justified in demanding a better elephant.

Industrial Railways for Manufacturing Establishments. C. W. Hunt Company, 45 Broadway, New York. 40 pp., 7 × 9¾ in. [Not standard size.]

The C. W. Hunt Company makes light railways, coal-handling machinery and conveyers for carrying coal and a great variety of other materials and products about manufacturing and other establishments. Mr. Hunt, the head of this establishment, has developed a very complete system of light, narrow-gauge railways and rolling stock for such purposes, and the amount of ingenuity that has been exercised thereon is indicated by the fact that the machinery and appliances manufactured by this company are covered by no less than 91 patents. For the purposes aimed at this company has developed a system of narrow-gauge roads, in which, as far as possible, everything is reduced to standard forms and dimensions. A peculiarity of this system is that the flanges of the wheels are placed on the outside of the rails instead of the inside, as on ordinary railroads. The axles of the cars are arranged so that they will assume radial positions to the curves. The outer rails of curves are made of a special form, so that in running over them the flanges of the outside wheels bear on the rail, and carry the weight of the car. The proportion of the curves and of the wheels and the adjustment of the axles are so arranged that the tread of the inner wheels and the flange of the outer one form parts of a curve whose vertex is at the centre of the curve. As the axles can assume radial positions, the wheels will roll around curves with practically the same ease as on a straight line. The flanges are placed on the outside of the rails for the reason that on reaching a curve the flange of the wheel on the inner rail impinges against the latter. The resistance thus encountered tends to push the axle into a radial position, whereas if the flanges are on the inside of the rails, the flanges on the wheels on the outer rail come in contact with it, and the resistance encountered would then tend to move the axle in the wrong direction. For this reason the arrangement of flanges on the outside of the rails offers less resistance, and for roads of this character is preferred.

The standard gauge adopted for these roads is 21½ in., measured to the outside of the rails ; and standard curves of 12 ft. radius, which are made in sections, are furnished. The tracks are laid on steel ties. A great variety of cars for different purposes and other appliances with plans of works showing arrangements of tracks, etc., are also shown.

The illustrations are good, without being first class. A fuller description of the arrangement by which the car axles act radially is, however, needed ; and one is disposed to ask why cuts are designated by numbers running up into thousands—one of them is No. *A* 1,377. It requires a waste of intellectual force to apprehend this designation, when in reality it would be simply fig. 9 in the book if the illustrations were numbered consecutively. Surely things are hard enough now to understand without adding artificial difficulties of this kind.

The book is well printed, the description clearly written, and is altogether satisfactory. An ingenious sub-advertisement was enclosed with the pamphlet, and consisted of a table of the H.P. of transmission ropes, and another and a very convenient "metric conversion table" arranged by Mr. Hunt, and printed on gummed paper "for convenient insertion in memorandum books." This is an example which might be advantageously followed by other publishers of trade catalogues. Give us your important facts in tabular or other convenient form, and they will be preserved. The tables sent by the Hunt Company we have inserted in our "Molesworth," where they will remain.

EXCESSIVE COST OF LOCOMOTIVE REPAIRS.

Editor American Engineer and Railroad Journal :

From calculations made from a table of locomotive returns for September, 1894, printed on page 42 in your issue for January, 1895, I find, estimating the cost of an engine to be $10,000, the average proportional share of that engine cost, expended annually for its maintenance, to be 12.7 per cent.

The highest mileage cost for repairs, 8.21 cents, which is shown in that table, is by the Norfolk & Western ; the least, 1.74, is by the Hannibal & St. Joseph. The annual per cent. of engine cost values of the same being, respectively, 25.98 and 5.18.

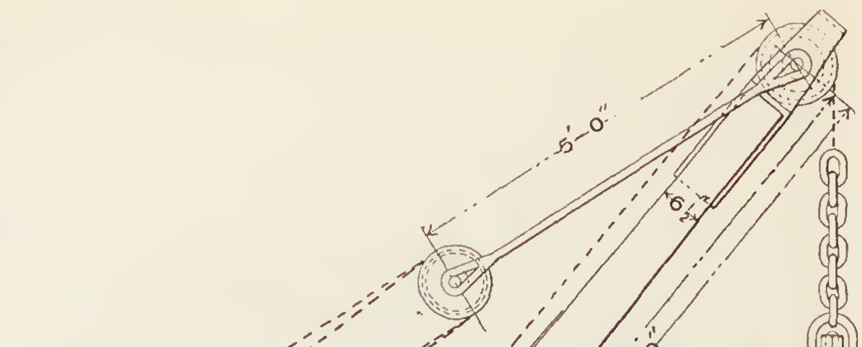
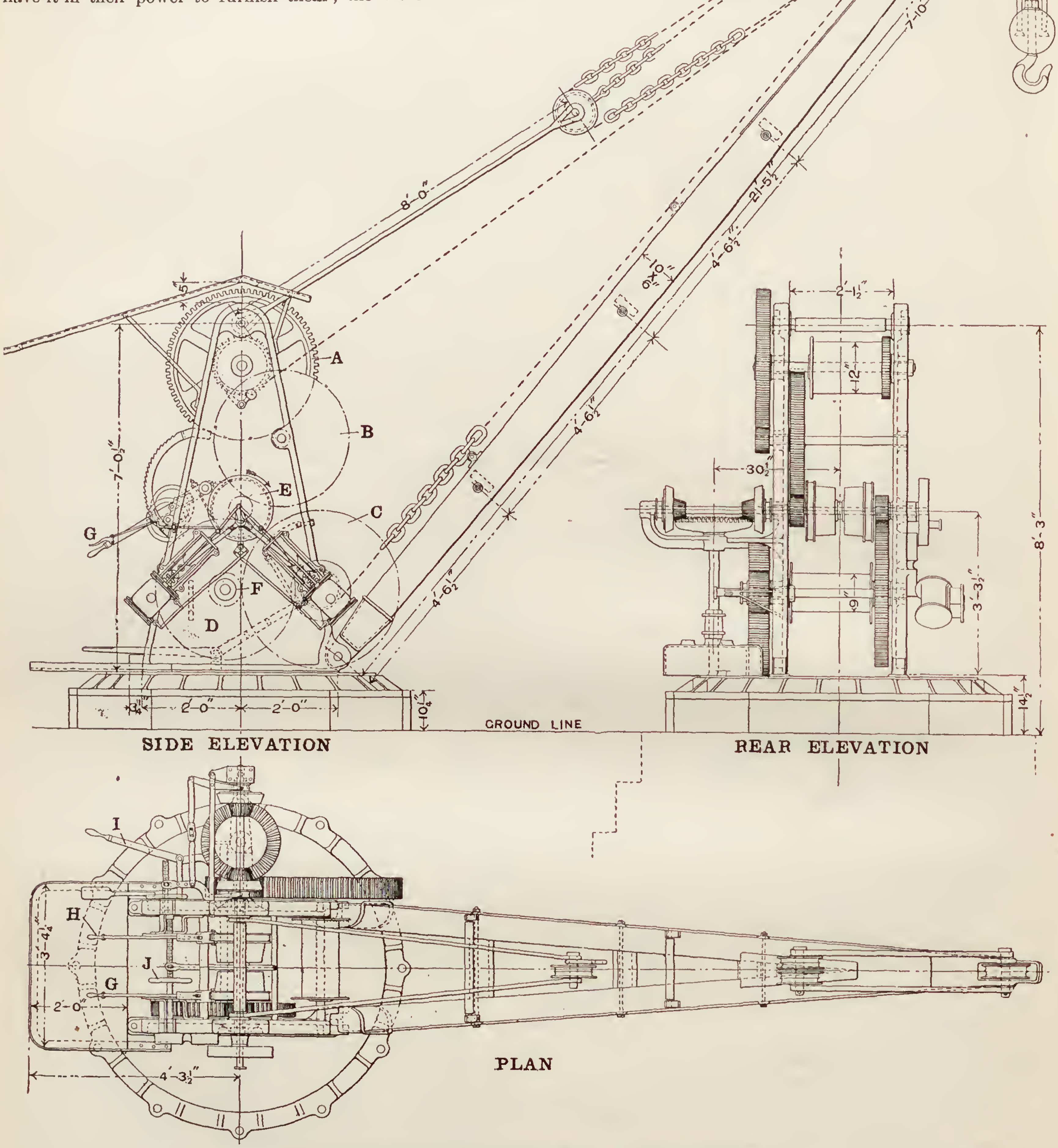
As to this same matter, I learn that for the entire Southern Pacific system the average yearly mileage per engine is 36,000, and that the engine mileage repairs for the same may be put at 6 cents, which, calculating as above, makes a showing required per engine per year for its maintenance of 21 per cent.

In considering this found annual repair percentage of cost, the question arises, Is it not excessive ? Does a quantity of machinery of like cost employed as a manufacturing plant anywhere, or for any purpose where there are fair conditions supplied as to stability, involve yearly anything like such a proportion of its value ? While, in the absence of positive figures in relation to it, from conclusions based on many years of practical use and observation of mechanical plants working under more clean and stable conditions than does that of a railroad's rolling plant, I am sure that the last far and, in comparison, ruinously exceeds the first. This being true, is it not to the general instability and the unevenness of the rail's plane, especially at its joints, as a path for engine and

car-wheels, the consequent variety and suddenness of motions which are thus engendered in the moving masses, the dust or mud, as the case may be, that is ejected from beneath the sleepers and forced into and among all the moving machinery—is it not to these and other like abnormalities that this excess should be charged ?

The question, then, is, How excessive is this annual rolling plant maintenance charge over that of fixed machinery operating, as such generally does, under the more favorable conditions ?

I seek reliable answers to this question from all who may have it in their power to furnish them ; the more numerous

FIVE-TON STEAM CRANE, BALTIMORE & OHIO RAILROAD.

the answers the better, for by such a more correct average may be determined. I therefore respectfully ask those who keep an account with their respective plants, other than those of a locomotive kind, to determine a fair cost value of the same, and from that, in connection with the annual repair or renewal charges entered against it, to compute the per cent. which is yearly required to maintain it in its original integrity. If those who can will do this, and at their earliest convenience, they will favor me much, and also contribute materially to the cause of applied mechanical science and to a needed fund of statistical knowledge as well.

Any conclusions that are the result of this inquiry will, when completed, be cheerfully mailed, on application, to those who may aid me in reaching them.

JOSEPH ANTHONY.

601 TEMPLE STREET, LOS ANGELES, CAL.

FIVE-TON STEAM CRANE, BALTIMORE & OHIO RAILROAD.

The engraving on page 252 illustrates a steam crane that was built at the shops of the Baltimore & Ohio Railroad, and is at work in their freight depot at Mount Claire, Baltimore. The crane is driven by a pair of engines having cylinders 5 in. in diameter with a 6-in. stroke of piston, and making 150 revolutions per minute. As will be seen from the side elevation, the cylinders stand at an angle of 45° with the vertical and 90° with each other, and their connecting-rods take hold of the same crank-pin. The main shaft crosses the crane, and on it are the pinions for hoisting, raising the boom, and swinging. The gearing for hoisting consists of a pinion 6.27 in. in diameter, having 13 teeth of 1½ in. pitch. It is on the main shaft, and can be thrown in and out of gear by means of a clutch operated by the hand-wheel *J*, as shown on the plan. This pinion meshes in with the gear *D*, 34.38 in. in diameter, having 72 teeth, that is on the same shaft with a pinion, *F*, of 19 teeth and 2 in. pitch, meshing in with the gear *C*, having 60 teeth that is on the winding drum. Thus, when the engines are running at 150 revolutions per minute, the winding drum turns at the rate of about 8½ revolutions, giving an average hoisting speed of something more than 30 ft. A 1-in. chain 42 ft. long is used for hoisting, and carries the load direct. The load is held by a strap-brake acting upon a drum fastened to the pinion on the main shaft, and operated by the lever *G*.

The gear for hoisting the boom consists of a 6 in. pinion having 15 teeth of 1¼ in. pitch, that is driven by a clutch on the main shaft operated by the lever *H*, shown on the plan. This pinion meshes in with a gear, *B*, having 83 teeth, that is on the same shaft as a pinion of 13 teeth and 1½ in. pitch, that meshes with the gear *A* on the winding drum. The chain used is made of ⅝-in. iron, is 46 ft. long, and is rove in fourfold for taking the strain. The boom can be held by a strap-brake operated by the handle *H*, but when out of service it is ordinarily held by a dog and ratchet-wheel, shown in dotted lines in the side elevation.

The crane can be swung in either direction by means of bevelled pinions on the main shaft that are shown in the rear elevation, and have 12 teeth meshing in with a horizontal gear of 48 teeth, that is keyed to a vertical shaft carrying the driving-pinion at its lower end. As one or the other of these pinions is used for driving the crane will swing to the right or left. The clutches for this work are connected by the system of levers shown in the plan and operated by the lever *I*.

The boom is made from two sticks of yellow pine 10 in. × 6 in., tapered toward the ends and bolted together with ⅞-in. bolts and separating pieces. The working parts are held by a substantial iron frame, the principal dimensions of which are given upon the engravings. Such a crane as this is of very cheap construction, and for handling freight of even moderate weights it has been found to be exceedingly convenient, and has effected a great saving in the work done about the depot.

YARD ARRANGEMENTS ALONG HEAVY-TRAFFIC HIGH SPEED RAILROADS.*

By A. Flamache.

(*Concluded from page 229.*)

CONCLUSIONS.

If we make a careful examination of the ideas which precede, we will see that their spirit tends toward an ideal arrangement, the scheme for which is shown in fig. 52—an arrangement which is evidently possible in principle, and its complete application is merely a matter of expense.

We can express the same order of ideas in another way by saying:

"Any junction station whatever being given and being supposed to be treated by taking account as far as possible of the local exigencies of the case (even admitting the actual state of things to correspond better to these exigencies), then we may suppose that we lead off sidings from the two main tracks which are reserved for the sole use of trains in transit, giving us fig. 54, which can be rectified by rearranging the two tracks, as in fig. 55, when we thus obtain the type which it should be our constant effort to attain."

It is evident that a train in transit will only pass one point switch, and that at the beginning of the yard, and one trailing switch; there are also two cross-overs on the track next to the local tracks.

To this minimum it is well to add two other switches, one point and one trailing, which would necessitate the doubling of the track *B* in order to permit the side-tracking of trains running over this line, without compelling them to cross the main line *A*. The two cross-overs can also be avoided by the adoption of junctions with an underground passage, as shown in fig. 28.

We can at once see the great advantages that the method of arrangement which we have advocated possesses and which we can summarize as follows:

From the Standpoint of Operation.—It is the one most favorable to the handling of high-speed trains, and, at the same time, it leaves the service to the widest liberty of choice as to the local arrangements.

From the Motive Power Standpoint.—Causes for slackening speed being avoided, a given commercial speed can be far more readily attained. The number of signals which the driver is obliged to observe is reduced to as few as possible.

From the Standpoint of Switches, Signals, and Permanent Way.—The maintenance of the main tracks, and especially of the apparatus which is in use, is greatly facilitated, as well as the wear and tear of the working parts reduced. The frequent changes that the modifications in the local service may require in order to adapt it to circumstances that cannot be foreseen should be made exclusively on the secondary track—that is to say, so that they cannot be interrupted by the passage of high-speed trains.

The question of cost then remains. The application of this system to the stations taken as an example have convinced me that this combination, which is so favorable in its results, is, at the same time, the most economical. If it necessitates the acquisition of certain supplementary land in order that the main lines may be doubled, it shows a marked saving in the location of tracks and signal apparatus, a saving that will repeat itself in a few years on heavy traffic lines.

* Bulletin de la Commission Internationale du Congrès des Chemins de fer.

NOTES AND NEWS.

A Large Tire.—The Midvale Steel Company have recently rolled what are, we believe, the largest steel tires that have as yet been made. They are 108 in. outside diameter, and were rolled in their regular tire mill. The use to which they will be put will be that they are to be shrunk upon the rim of some heavy belt and fly-wheels intended for the high-speed engines of an electric-lighting plant.

Reserved Seats.—A measure for permitting passengers to retain the places they have chosen in the compartment of a railway carriage is under consideration by the French Minister of Public Works. The idea is to pin to the lining of the carriage a piece of colored cloth corresponding with another given to the passenger, and rendering any tampering with them liable to a fine of £4.

High Resistance Shunt around Circuit Breaker.—Mr. Thomas Coykendal, the Chief Engineer of the Cornell Steamboat Company, has introduced a novel method of indicating the continuance of the short circuiting of the line in the power house of the street railway at that place. It is the practice on some roads, when the circuit breaker flies out to replace it at once, and then, if it flies out again, to replace it once each minute until it remains in place, a practice, by the way, that may result in the wrecking of a portion of the machinery or the development of beautiful but expensive fireworks, as was shown in the case of the Cincinnati power house. Mr. Coykendal's device consists in a high resistance coil of German silver having a resistance of 7 ohms, that forms a shunt around the circuit breaker, and while the latter is in place it is non-operative, but when the breaker is out it will carry enough current to the line to light the cars nearly as well as when the circuit breaker is closed, or move a car away from a position where it is an obstruction or in danger, as upon a railroad crossing. The electrician, then, instead of throwing the circuit breaker back, merely watches the ampère meter, which rises to 75, until it drops back to 45, when the breaker will remain in position, and it can be put back without danger.

The Temperature of Feed Water Delivered by an Injector.—In response to an inquiry made to the Nathan Manufacturing Company with reference to the temperature of water fed into a boiler by an injector, they have supplied the following very interesting information. They say:

"We take pleasure in giving herewith the results of actual experiments just made on the lines suggested by you. The

temperature of the feed-water as delivered into the boiler by an injector or steam jet apparatus is influenced, apart from the steam pressure, by the quality of the steam (whether dry or wet), by the lift which the injector is called upon to overcome, by the initial temperature of the feed water, and by the capacity of the injector—that is to say, whether it be worked to its maximum capacity or not. With a lift varying from 4 to 5 ft., an initial temperature of the feed water of 75° F., and with steam and water valves of the injector open to their full, we have delivered water into the boiler at the following temperatures under varying steam pressures :

Pressure per square inch.	Temperature of delivered water.
140 lbs.	200° F.
150 "	210° "
160 "	222° "
170 "	230° "
180 "	236° "
190 "	244° "
200 "	250° "

" After these tests had been made we attempted to repeat them with a lift reduced to 2 ft., when our thermometer ' went back ' on us by bursting, putting a sudden end to our experiments."

A Limit of Speed for Trolley Cars in Brooklyn.—In a recent discussion before the Board of Aldermen in Brooklyn, it was stated by one member that already 103 lives had been sacrificed under the trolley wheels in that city, and 407 persons had been maimed.

Lawyer Raphael J. Moses has submitted a volume of alleged reliable and startling information to Mayor Schieren about the actual speed of the trolley cars. He furnished a series of tabulated statements which show that in one instance as high a speed as 30 miles an hour was reached, and in very many instances 20 miles.

He says that each case is attested by the affidavits of two railroad men, who actually rode in the cars and noted the time of starting and arriving. Some of the affidavits treat of the speed in passing school buildings. This shows, according to Lawyer Moses, " the shameful rate of 17 to 20 miles an hour." Mayor Schieren has forwarded copies of the affidavits to all the railroad Presidents.

An ordinance was finally adopted which provides that the speed of the trolley cars shall not exceed 6 miles an hour within a radius of ½ mile from the City Hall and ferries, 8 miles an hour within a mile of these points, and 10 miles an hour in the other sections of the city. The cars must also come to a full stop at steam railroad crossings, and shall not run faster than 4 miles an hour before crossing surface roads and before crossing Schermerhorn Street and Clinton Street.

The platform gates on the track side are to be kept closed, the cars must be licensed, and not more than three persons are permitted to ride on the front platform. The police are to be required to enforce the trolley ordinances, and each violation calls for the imposition of a $25 fine.

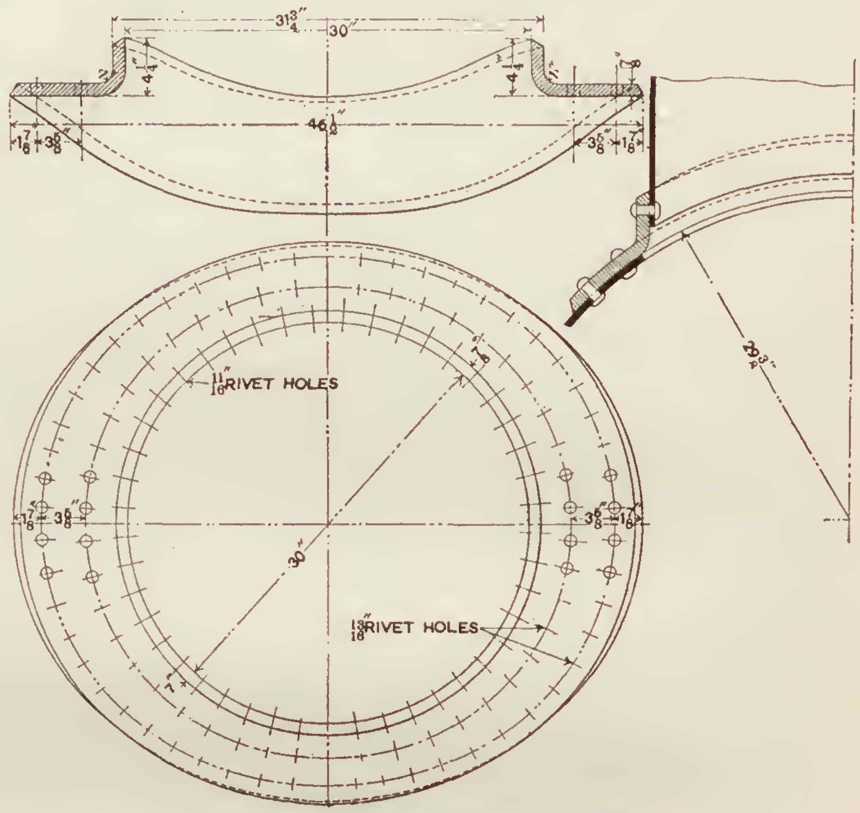
Dangers of Defective Eyesight.—A deputation from the British Ophthalmological Society recently waited upon Mr. Bryce, President of the Board of Trade, to urge the adoption of more precise tests for eyesight in the examination of the mercantile marine and railway servants.

A new system of tests, based on the report of the Committee of the Royal Society on Colour Vision (Parliamentary paper C—6,688, 1892) was brought into operation on September 1 last ; it covers a period of 15 months—*i.e.*, from the date of the previous report to the date of the introduction of the new system. The new examination consists of three parts —(*a*) the form vision test, which is intended to ascertain whether a candidate has good or bad sight ; (*b*) the color vision test, whether he can distinguish colors correctly ; and (*c*) the color ignorance test, whether he can name colors correctly. For form vision the candidate is examined by Snellen's letter test, or, if he cannot read, by the " dot" test. In the former case the candidate is required to read letters of different sizes arranged in rows on a sheet placed at a distance of 16 ft. from him. In the latter case the candidate is required to answer questions with regard to the number and position of dots arranged in different lines and groups on a sheet placed at a distance of 8 ft. The color vision test is conducted by means of Holmgren's wools. The candidate is required to select from a general heap of wools of different colors those skeins which in his opinion match with one or the other of three test skeins of the colors of (1) light green ; (2) pink or light purple ; and (3) red. The object of the color ignorance test is to ascertain whether the candidate knows the proper names of colors, so as to insure his being able to name correctly the red, green, and white lights. This test is introduced mainly to meet the case of foreign seamen serving in British ships. Full details of the new method are given in the Parliamentary paper already referred to.

The ophthalmologists admitted that the instructions for examination of the mercantile marine service issued by the Board of Trade proceeded upon true lines, except as regarded refraction.

A correspondent in *The Times* suggests that if the ophthalmologists could suggest some examination which would insure that look-out men should keep their eyes open during the night, especially in short-handed vessels, it might be more practical ; but certainly ships of war do not require this precaution.

Pressed-Steel Dome Base—Pennsylvania Railroad.—The hydraulic press having demonstrated its capability of forming intricate and varied shapes from sheet and plate metal, is receiving a more and more extended application for this class of work, and in addition to the several manufactories that are turning out stamped metal specialties, some railroad companies have found it economical to own their own presses and dies and form the parts for themselves. This can, of course, only be done where large numbers are wanted in duplicate. The Pennsylvania Railroad are now pressing a great deal of boiler work that was formerly done at the flanging forge. One of the



PRESSED-STEEL DOME BASE.

simplest pieces formed is the front flue sheet for locomotive boilers. The sheet is heated to an even temperature in a furnace and put into a heavy press made by the Morgan Engineering Company. A single stroke of the ram completes the operation, and the sheet is ready for drilling. Three men are employed on the work, and they can turn out a flue sheet flanged and straightened at the rate of one in about five minutes. Another part formed on this same press is the dome base, of which we publish an engraving. As all of the dimensions of the finished base are given, it is unnecessary to recapitulate them here. The original sheet is circular, 46½ in. in diameter and ⅞ in. thick. It is flanged and curved to fit the boiler shell by one stroke of the ram. It is riveted to the shell of the boiler by two rows of ¾-in. rivets, there being 46 in the inner row and 54 in the outer. It is held to the dome by 45 ⅝-in. rivets. The drawings from which our illustration is taken is of the base used on the Class P locomotives, the cylinders for which were illustrated in our last issue.

Severe Test of Armor Plate.—The 13-in. gun was fired at an 18-in. Carnegie plate at Indian Head on May 17, to secure a comparison of the damage created by its 1,100-lb. projectile and the 850-lb. shell of the 12-in. rifle, the object being to demonstrate that the new battleships should be armed with the larger guns. On May 1 a Holtzer shell from the 12-in gun in an acceptance test of the 18-in. side armor of the *Oregon* had been fired at the same plate that was used on the 17th, with a muzzle velocity of 1,926 ft. per second, and a striking energy of 21,885 foot-tons, and had cracked the plate from top to bottom, but had destroyed only one of its 26 armor bolts, the pro-

jectile penetrating 10 in. and then going to pieces, its point welding into the plate.

This shot had been fired with a velocity corresponding to the maximum striking velocity procurable from the 12-in. gun at 1,300 yds. range, which is estimated to be about the distance which would probably be chosen by battleships in action. The same conditions of velocity at the 1,300 yds. distance were observed with the 13-in. gun, the initial velocity to its 1,100-lb. Wheeler-Sterling solid steel shot being 1,942 ft. per second, or 18 ft. greater than in the case of the 12-in. gun, but the striking energy reached the enormous figure of 28,800 foot-tons.

The shot struck in the right half of the plate, breaking it in four pieces, and buried itself in the sandbank behind the plate, where, upon recovery, it was found to be broken to pieces, the head whole but somewhat fused at the point. The heavy oak backing behind the plate was completely demolished by the terrible energy of the blow. This clearly demonstrated the superiority of the 13-in. gun over the 12-in. weapon for the same range, and the ordnance officers present claimed it showed no armor in existence could keep out the 13-in. projectile at 1,300 yds. This, however, concededly depends on the projectile, as the next shot evidenced.

A Wheeler-Sterling semi-armor-piercing shell similar to the preceding one, but hollowed out to contain a 53-lb. charge of explosive, was aimed near the base of the armor where the plate tapered to 15.6 in. in thickness, the same velocity being used. The plate met with similar disaster, breaking and letting the shell through after it had penetrated 7 in. The shell broke up; all its fragments went through, and were found in the sand behind.

The experts, however, are not prepared to accept these performances as conclusive proof that 13-in. shells have yet been found to demolish 18-in. plates, or even plates of less thickness. The armor attacked had already stood the strain of two acceptance shots from the 12-in. rifle and one from the 13-in. gun, and two of these shots had split the plate through and through. As the dimensions of the plate were 16½ ft. long, 7½ ft. wide, 4 ft. of which was 18 in. thick, then tapering to 8 in. at the edge, there was no such exhibition of tenacity as would be looked for in a whole plate. The tremendous energy of a shot from the 13-in. "Peacemaker" is not doubted, but it is claimed that the comparatively insignificant penetration of the shells before the overstrained plate gave way and let them through is significant. Nevertheless, no doubt remains that the 13-in. guns of the *Massachusetts*, *Indiana* and *Oregon* could speedily destroy any warship afloat in the world to-day, and that the great battleships of the *Majestic* and *Magnificent* class now building in England, with their belts of 9-in. Harveyized armor, would not last any time if American gunners are skilful.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.

SECOND SERIES.—CHEMICAL METHODS.

XV.—METHOD OF DETERMINING TAR AND TAR ACIDS IN WOOD PRESERVATIVE.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(*Continued from page* 202.)

OPERATION.

Pour into a 100 cubic centimetre graduate 80 cubic centimetres of 88° B. gasoline, and add the material to be tested up to the 100 cubic centimetre mark. Put in the stopper and shake thoroughly. Allow to settle until the tar settles to the bottom, or, as happens in many cases, part of it settles and part adheres to the sides of the graduate. If the tar settles off nicely, none of it adhering to the sides of the graduate, read off the number of cubic centimetres occupied by the tar, and calculate the amount as described below. If any of the tar adheres to the sides of the graduate, add a few cubic centimetres of gasoline to a second graduate of the same size, drain it, and then quickly but carefully pour the gasoline solution from the first graduate into the second, taking care that none of the tar goes along with the gasoline. Stopper the second graduate quickly, and read off the amount of gasoline solution in it. The difference between this reading and 100 cubic centimetres, when corrected for the error introduced by the volatility of the gasoline, and the difficulty of pouring it all out, shows the volume occupied by the tar in the first graduate, from which the percentage can be calculated, as described below.

To determine the tar acids, pour 80 cubic centimetres of the gasoline solution, above referred to, into a clean 100 cubic centimetre graduate, provided the tar has been determined without transfer. If the transfer has been made, pour or suck out with a pipette the gasoline solution in the second graduate, until 80 cubic centimetres are left. Then add 20 c.c. of caustic soda solution, and 4 cubic centimetres of ordinary alcohol. Shake thoroughly, and allow to stand until the material separates into two layers. The tar acids and part of the alcohol go into the lower layer. Read off the volume of this lower layer and calculate the amount of tar acids, as described below.

APPARATUS AND REAGENTS.

The apparatus required by this method is a 2 cubic centimetre pipette to measure the alcohol, and several 100 cubic centimetre graduates provided with glass stoppers and feet, so that they will stand. The flat form is much better than the round form, since the solution of wood preservative in gasoline is moderately dark, and the readings can be much better made if the mass of liquid is in a layer thin enough, so that light is readily transmitted through it.

Gasoline of the gravity specified is readily obtained in the market.

The alcohol is the 95 per cent. grade.

The caustic soda solution is made by dissolving a pound of commercial stick caustic soda in a quart of water, and diluting with water until it shows a gravity of 13° B. Of course the gravity measurement should be made after the liquid has cooled to the temperature of the air.

CALCULATIONS.

I. *Tar when it Does not Adhere to the Graduate.*—Since 20 cubic centimetres of the wood preservative are taken to start with, if the volume of the tar obtained by reading the graduate is 1.5 cubic centimetre, for example, it is evident the amount of tar is $(1.5 \times 100 \div 20 =)$ 7.5 per cent.

II. *Tar when it Adheres to the Graduate.*—If the gasoline solution could be poured off completely from the tar into the second graduate, and if none of it volatilized, it is evident that the calculations could readily be made from the readings described. But experiments indicate that there is a little vaporization of the gasoline and a little difficulty of pouring off completely. Accordingly, an allowance of 1 cubic centimetre is made for these errors. Suppose now, after the transfer, the reading of the second graduate is 97 cubic centimetres. This from 100 leaves 3 cubic centimetres for the tar; but the error of the transfer is 1 cubic centimetre. Hence, the actual volume occupied by the tar in the first graduate is 2 cubic centimetres, and the amount is $(2 \times 100 \div 20)$ 10 per cent.

III. *Tar Acids.*—Let us suppose that the reading of the graduate, after treatment with the soda and alcohol, as described, is 32 cubic centimetres. Twenty of these we added with the soda. Furthermore, experiment shows that 3 of the 4 cubic centimetres of the alcohol added go into the lower layer with the tar acids and soda solution. Therefore the increase in volume due to tar acids is $(32 - 23)$ 9 cubic centimetres. Suppose, now, the volume of the tar found, as above described, is 2 cubic centimetres. Also, it is allowed that 1 c.c. of the gasoline solution is lost during the transfer from the first graduate to the second, whether this transfer is made after the tar determination, or as a part of this determination, as described. There would be, therefore, 97 cubic centimetres of gasoline solution, which contains all the tar acids. But in the case supposed we find that 80 cubic centimetres of this solution contain 9 cubic centimetres of tar acids. Therefore 97 cubic centimetres, or the whole of the gasoline solution, contains $(80 : 97 :: 9 : 10.91)$ 10.91 cubic centimetres of tar acids, or this amount differently expressed is $(10.91 \times 100 \div 20)$ 54.55 per cent. This explanation may be briefly summarized as follows: Subtract 23 from the reading obtained when determining tar acids, and call this remainder a. Deduct from 100 cubic centimetres the number of cubic centimetres showing the tar and one more. Call this remainder b. Then make a proportion $80 : b :: a : x$. x shows the volume in cubic centimetres of the tar acids, and from this calculate the percentage.

COAL STORAGE PLANT AT PORT RICHMOND, PHILADELPHIA, PA., FOR THE PHILADELPHIA & READING RAILROAD, ERECTED BY THE DODGE COAL STORAGE CO.

NOTES AND PRECAUTIONS.

The material to which this method applies is a distillate of Georgia pine, known under various trade names, such as fernoline, spirittine, pine oil, etc. It is, of course, not applicable to all wood preservatives, and those made from other kinds of wood and from coal tar do not behave, when treated as the method describes, like the Georgia pine distillate.

If the 20 cubic centimetres of the distillate are poured into the graduate and then the gasoline added, it is much more difficult to get the gasoline and distillate thoroughly mixed than if the manipulation described is followed.

It will be observed that what is counted as tar is the material which separates from the distillate when treated with gasoline under the conditions described. No special effort has been made to determine what this is chemically, nor is it known whether the separation of the tar is complete or not. Also, there is some evidence that some of the gasoline remains dissolved in the tar, and increases its volume somewhat. No method is at present known of avoiding this difficulty, and accordingly the determination of the tar may be said to be in a sense arbitrary. But as long as the conditions and limitations of the method are known and understood, it is felt that no injustice is done by its possible and necessary errors.

There is quite a difference in distillates. Sometimes the tar will settle off nicely into a clean layer at the bottom of the graduate, whose volume can be easily read off. More often, however, the tar separates in flocculent sticky particles or clots which adhere quite firmly to the glass. The cause of this difference in behavior is not known.

The object of adding a few cubic centimetres of gasoline to the second graduate and draining, before the transfer, is to compensate in the tar determination for the volume of the gasoline solution that adheres to the sides of the first graduate. While this source of error may not be serious compared with some necessary errors in the method, it is thought best to avoid known sources of error as much as possible.

It is perhaps hardly essential to mention that when the transfer is made to measure the tar, the two graduates used must be alike in measurement.

It will be observed that there is an error in the tar acid determination when the transfer is made as a part of the tar determination, due to the fact that some of the gasoline solution holding tar acids remains sticking to the sides of the first graduate. There is no means at present known of avoiding this error. It is believed, however, that this error does not amount to more than 1 per cent., and perhaps less.

The use of alcohol in the tar acid determination is due to the fact that without the alcohol the line between the two layers is not sharp. Apparently some of the soap formed by the combination of the tar acids with the soda does not dissolve in the soda solution in absence of alcohol. In its presence the difficulty wholly disappears.

Direct experiment, made by adding to a 100 cubic centimetre graduate 20 cubic centimetres of the soda solution, 80 of the gasoline, and 4 of alcohol, shows that 1 cubic centimetre of the alcohol goes into the gasoline and 3 into the soda solution. It will be observed that it is assumed that the same thing takes place when the distillate is present.

The amount of gasoline vaporized during the transfer is, of course, affected somewhat by the temperature at which the transfer is made. Also, the manipulation has an influence. It is believed that the 1 cubic centimetre allowance should cover the necessary errors introduced by the volatility of the gasoline and the difficulties of the transfer.

The reason why so volatile a substance as gasoline is used to separate the tar is because no non-volatile material is known which separates the tar as satisfactorily as gasoline. Experiments with heavier non-volatile petroleum products have been made with unsatisfactory results. It is quite probable that further study will develop a more satisfactory solvent. It is, of course, well known that gasoline is not the only solvent that will separate tar from this distillate. It is, however, cheap and efficient, and may therefore reasonably be used until something better is suggested.

What is classed as tar acids, it will be observed, is what goes into the caustic soda solution. What these acids are, whether the separation of them from the neutral oils is complete, and whether anything else than tar acids and alcohol go into the soda solution, is not definitely known. In a sense, therefore, the determination of the tar acids is arbitrary.

Notwithstanding all the precautions that can be taken, it will be observed that the necessary errors of the method may be quite considerable. It is not expected that very sharp results can be obtained, but the limitations of the specifications under which the material is bought are so broad that very little difficulty has arisen, and the method has proved an excellent means of keeping moderate control over an important commercial product whose chemistry is very little known.

COAL STORAGE PLANT AT PORT RICHMOND, PHILADELPHIA.

The Dodge Coal Storage Company, of Nicetown, Pa., are just finishing a very extensive and complete coal storage plant, having a capacity of 180,000 tons, for the Philadelphia & Reading Railroad. It is being erected at Port Richmond, just north of the present storage yards of the railroad company.

The Dodge system of handling, storing and reloading the coal is simple and unique. From the time the car is run over the hopper into which it is unloaded until the coal is reloaded in the cars for shipment there is no shovelling, and no handling is required other than the raking up of a thin layer of coal that is left upon the ground when it is desired to use the floor for coal of a different size. The handling is done by means of scraping conveyers using the well-known Dodge chains, and though the height of the centre of the pile may be, as in the case under consideration, more than 70 ft., the coal need never be allowed to fall more than from 12 in. to 15 in., so that there is practically no breakage whatever.

Ordinarily the coal is stored in conical piles, but there have been cases where a very much greater storage capacity was desired than the ground room available would permit were conical piles alone to be used, and where an ingeniously braced enclosure was introduced that practically placed a cylinder of coal of the height of the enclosure and of the diameter of the pile beneath the conical portion. Such a system was used at the West Superior plant erected for the Lehigh Valley Railroad.

The general appearance of the plant is well shown by the half-tone reproduction of a photograph taken after the trimmers had been put in place, and while the buildings and other iron work was still in course of erection. The photograph was taken from the southeastern extremity of the plant, looking toward the opposite diagonal corner. The plot of ground that has been set aside for this purpose lies between Ann Street on the south, Byron Street on the north, the Philadelphia & Reading tracks on the east, thus closing Bath Street and the rear end of the lots fronting on Melvale Street to the west. The total dimensions within the enclosure are: Length, 1594.4 ft., and breadth 335 ft. from the centre of the unloading track. The arrangement of switches, main tracks and sidings for the yard is clearly shown by our engraving (fig. 1). From this and the photograph it will be seen that provision is made for the formation of six piles; the two at the ends will have a capacity of 20,000 tons each; the intermediate piles a capacity of 40,000 tons each, and the centre piles a capacity of 30,000 tons each. It is usually customary to place one reloader for each two piles; but in this case, in order to expedite the reloading for shipment, four reloaders are used, and these are so disposed that each of the 40,000-ton piles can be attacked from opposite sides at the same time. It is expected that the capacity of these reloaders will be 3 tons each per minute. When the plant is started, or when the reloaders are not at work, they stand out at right angles from the towers which they supply, so that they may not be buried under the coal, and it is in this position that they are shown in fig. 1, being marked *W*, *X*, *Y* and *Z*. The heavy outside circles that are concentric with the centre of the trimmers indicate the outside limits of the bottoms of the several piles; the circles in fine lines concentric with the heel or pivot of the reloaders are the rails upon which they (the reloaders) run, and the straight lines leading from the centres of the trimmers are the guy lines holding them in a vertical position. The location of the boiler-house, engine-house, hoppers and towers are also clearly shown. The steam plant consists of two 150-H.P. boilers placed in a house located on the transverse centre line of the plant, and from which the steam is piped to the several engines. The furnaces are designed for burning screenings and dust on the McClave grates with steam blowers that have been so successfully used in the anthracite mining regions for burning culm. In each of the four engine-houses there is a 100-H.P. engine for driving the machinery.

In fig. 2 we have an outline of the trimmers. The trusses are so designed that a certain number of bents at each end are standard, so that they are available for use with any span of trimmer that is likely to be erected, the intermediate bents being put in as the occasion may demand. It will be noticed that the angle made by the trimmer girders with the horizontal is about 27°. The contractors have found, as the result of their experience, that this is nearer the angle at which loose

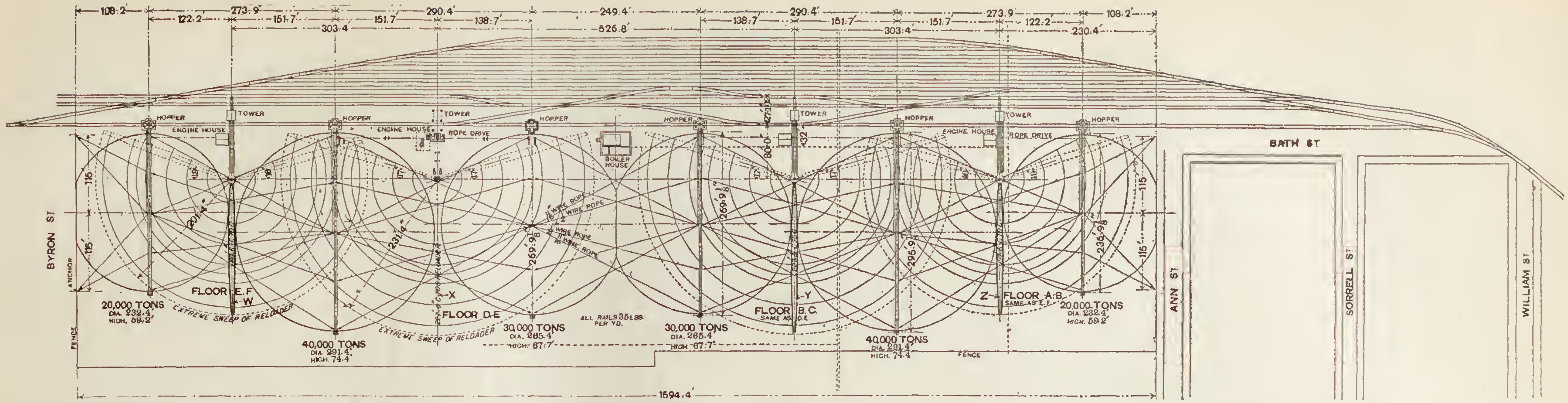


Fig. 1.

GROUND PLAN OF COAL STORAGE PLANT OF PHILADELPHIA & READING RAILROAD AT PORT RICHMOND.

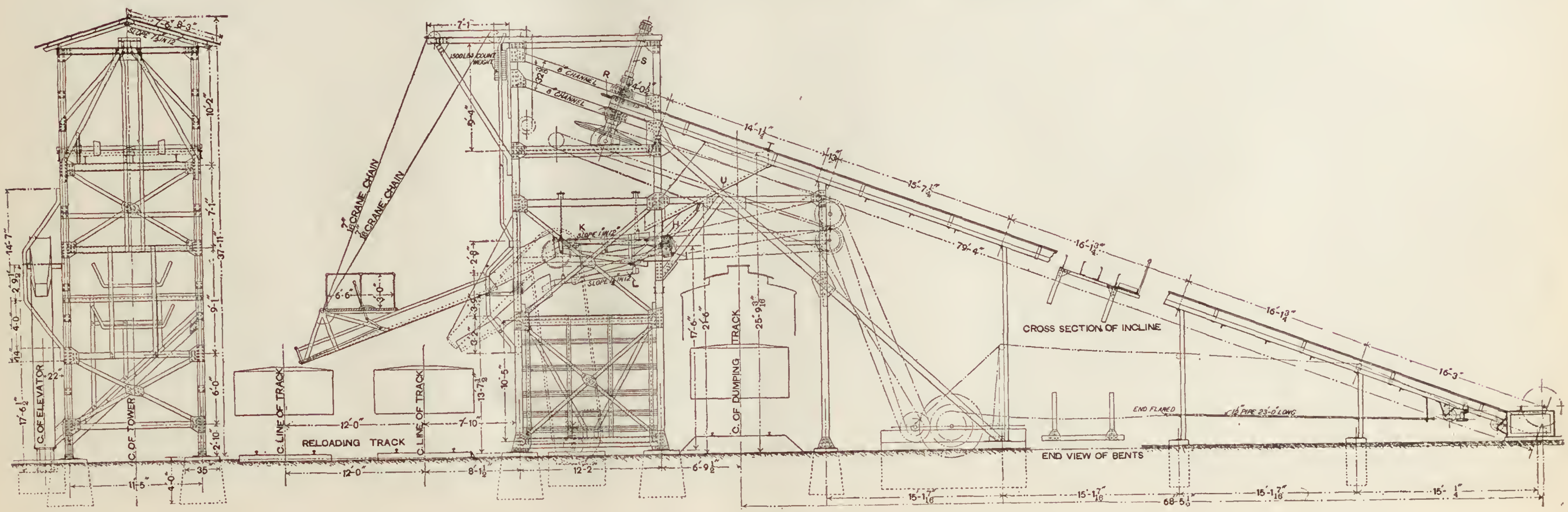


Fig. 4.

SIDE ELEVATION OF RELOADING TOWER OF COAL STORAGE PLANT AT PORT RICHMOND.

coal will stand than 30°, as is usually given in text and pocket-books for the angle at which coal begins to move.

The system of storing the coal is very simple. Beneath the entering track, and directly in a line with the centre line of the trimmer as shown in fig. 1, there is a hopper into which the cars are dumped, and which has a capacity sufficient to take the whole load of the car. A chute in the bottom of the hopper, controlled by a sliding door, delivers the coal by gravity into the foot of the inclined trough that leads to the top of the trimmer. In this trough the scraping conveyer works, its course being indicated in fig. 2. Starting with its load at the bottom of the hopper between the rails, it moves up through the trough to the apex of the trimmer, returns along the line indicated above the bents, passes over the idle pulleys *M* and *N* (fig. 2), and thence to the foot of the incline. The driving pulley of the conveyer is at the top of the trimmer, and it is in turn driven by a rope leading off from pulleys in the nearest engine-house. Thus the pull is at the delivery end of the loaded chain.

We have said that the system is so designed that the coal need never be allowed to fall more than from 12 in. to 15 in. in the plant. This would, of course, be impossible were it carried to the apex of the trimmer before it were allowed to fall to the floor below. To obviate this difficulty and secure the desired end, that portion of the conveyer trough which is on the trimmer proper is left open at the bottom from a point near that indicated as *P*. Thus, when commencing operations with an empty floor, the coal drops out at this point and starts the pile. Beneath the tower *Q* carrying the rope-drive, and below the bottom line of the trough, there is a reel upon which a steel ribbon $\frac{3}{32}$ in. thick and 12 in. wide is rolled. The end of this ribbon can be drawn out and up by means of a windlass and a wire rope to the apex of the trimmer. Therefore when the pile has reached to within about a foot of the discharge opening, this ribbon is run out, and, forming an extension to the bottom of the conveyer trough, it carries the point of discharge out and up, the process being repeated until the pile is completed and the floor full. These conveyers are to run at a speed of 200 ft. per minute, and will have a capacity of 3 tons per minute.

Fig. 3 shows in some detail the plan of the pivot end of the reloader. This portion of the apparatus consists of an arm varying in length according to the size of the pile to be attacked, as given in the dimensions marked on fig. 1; the arm is pivoted at one end and rests upon small flangeless wheels running upon the circular rails, weighing in this case 35 lbs. to the yard. The reloading arm is swung by means of anchor lines that run along the outside of one of the rails near the outer extremity, and which are firmly anchored to the ground just outside the extreme throw, which ranges through an arc of 204°. These anchor lines pass over pulleys properly located, and then pass through a length of gas pipe to a point near the centre, where the arrangement of sheaves is like that shown in fig. 3. The pipe is used to do away with sag and slack, and the sheaves are so adjusted as to keep the length of the hauling lines as nearly constant as possible. The pipe connections are shown at the left of the engraving, while to the right the lines lead off to the winding drums. The conveyer is an open-side scraper conveyer operated with a Dodge chain and cutting into the side and foot of the coal pile. The operator stands on the pivot platform, and by means of hand-wheels controls the motion of the conveyer and the swinging of the reloader. The operation is apparently simple: the hauling line is drawn in until the conveyer bottom cuts into the pile and the scrapers bring the coal up to the centre, and then as the supply falls off the reloader is swung in more and more until the whole pile is removed. The skill in handling comes in the prevention of a downfall and consequent burying of the reloader. While the natural quiescent inclination of a coal pile is about 27°, when that same coal has been subjected to a compression of a superincumbent weight, and the pile is eaten into from

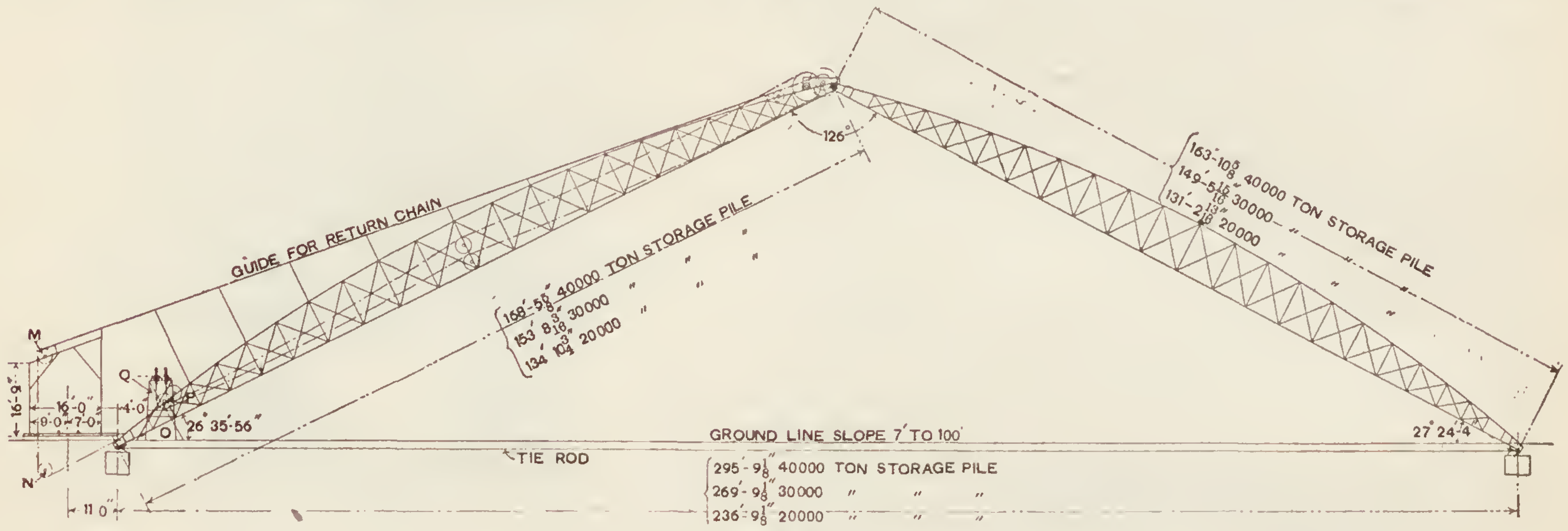


Fig. 2.

OUTLINE OF TRIMMERS OF THE PORT RICHMOND COAL STORAGE PLANT.

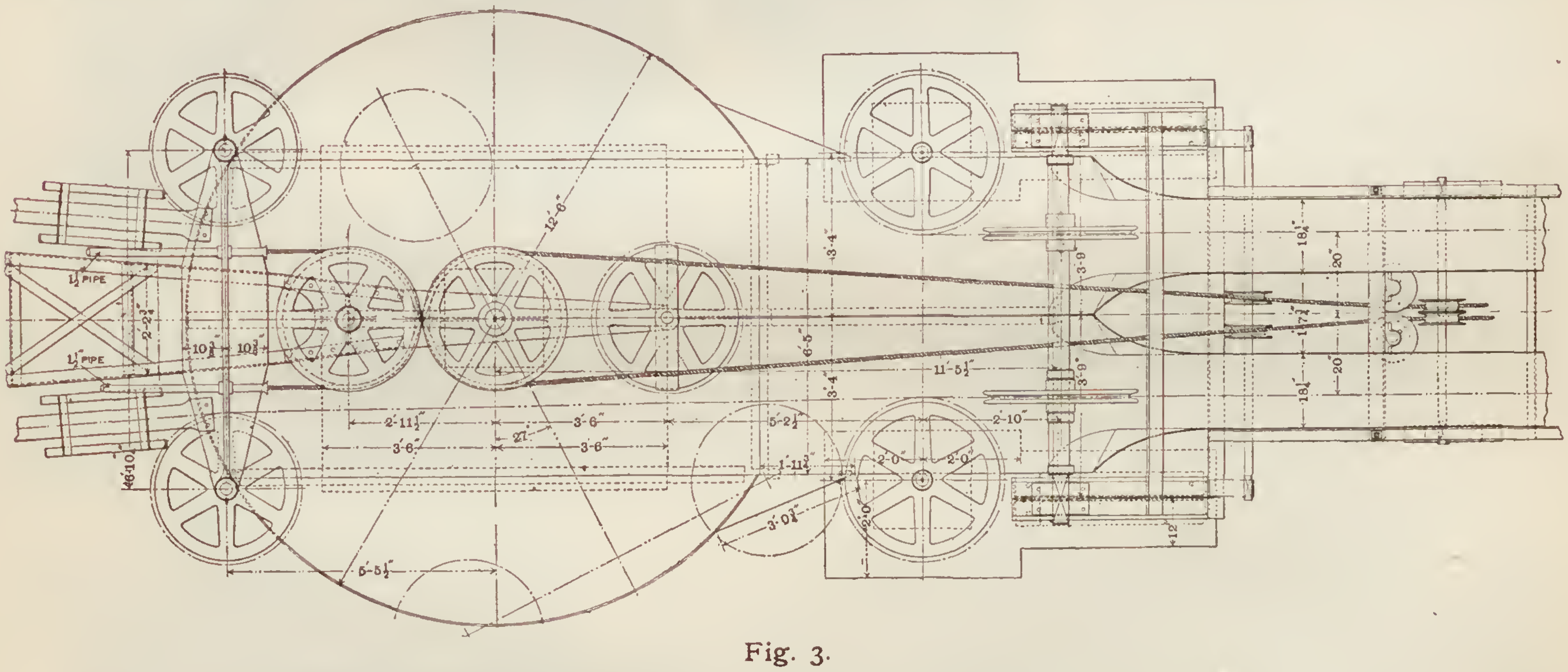


Fig. 3.

PLAN OF PIVOT OF RELOADER OF COAL STORAGE PLANT AT PORT RICHMOND.

the bottom, that same coal may stand at a very much steeper angle, and this may result in an avalanche when the foundation has been sufficiently cut away. The skill of the operator is made manifest by the alertness of eye by which he detects the first symptoms of a coming fall, and backs the reloader out of the way.

When the coal leaves the reloading arm it is carried up the incline shown coming down to the right in fig. 4. The conveyer chain passes around the sprocket wheel *R* that is keyed to the inclined shaft *S*, while the coal has already been delivered at the point *T* lower down the slope into the inclined trough *U*. This trough has an inclination of 6 in 12 that causes the coal to flow rapidly and freely into the upper shaking screen *K*, which is given 131 vibrations a minute by the eccentric *H*, to which it is attached by means of a long eccentric-rod. The coal escaping from the end of this screen drops upon an incline of 1 in 12 and thence into an adjustable chute for delivery into the cars on the outer shipping track. This chute is slung by suspending chains from a bracket on the tower, and is raised or lowered by the man in charge on the platform, where his lever is shown. Reference to the engraving (fig. 4) will show that there is a gate at the foot of the chute controlled by the lever, so that the flow of coal to the car can be temporarily stopped without stopping the conveyer itself.

The coal that drops through the screen *K* falls upon the screen *L*, which also has an oscillating motion of 131 vibrations per minute from the eccentric *I*. The coal is delivered into a chute and falls into cars on the loading track next the towers, and which is marked *G* in fig. 1. Each tower, therefore, screens and delivers two sizes of coal to the cars. The dust falls into a bin occupying the whole base of the tower, and from which it is taken through a suitable opening. This will be the fuel used under the boilers of the plant, and the excess will be removed by hand to cars and hauled away.

The whole of the structural work of the plant is of steel, and the work has been most thoroughly done. The engines are coupled direct to the main line of shafting, and this is cut up and subdivided by friction and tooth clutches, so that each and every moving part can be handled independently of all of the others. The system has been in use for a number of years, and is being widely introduced by coal handlers who find it necessary to store large tonnages. Among other large plants that have been erected, there is one at West Superior, to which allusion has already been made, which has a capacity of 100,000 tons in two piles; one at South Amboy, with a capacity of 190,000 tons, in 16 piles; and another at South Plainfield, of 310,000 tons, in 14 piles.

SOME FACTS RELATING TO CERTAIN TYPES OF WATER-TUBE BOILERS.*

(*Concluded from page* 219.)

THE AGGREGATION OF PIPE AND FITTINGS.

This stage of boiler-making occupies the same plane in boiler development that the rotary engine does in its field. Almost everybody has been touched by the disease. The materials are all at hand, and the details can be mostly bought ready made. By the addition of another elbow, coupling or return bend, the budding genius of a boiler inventor sees the heights of fame and dollars within his reach.

As a rule it can be said that the later the date of the attempt the worse the results.

They are all based on the following recipe:

First, crowd in the greatest possible amount of heating surface, no matter how or at what sacrifice of other equally necessary requirements.

Second, the more bends and right angles so placed as to obstruct circulation the better.

Third, on the same basis that a steam-engine will run more regularly without than with a fly-wheel, cut down the steam and water capacity to the lowest possible limit.

Fourth, make it as far as possible out of pipes and fittings screwed together, and place the fittings and joints in the hottest position.

Fifth, firmly take the position that it will never need repairs, and render them difficult to make.

Sixth, assert that it will never need internal cleaning, and avoid all facilities for so doing.

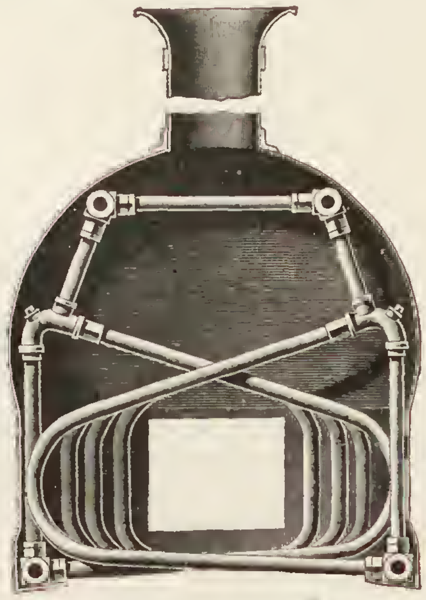


Fig. 48.—DANCE'S BOILER, 1833.

"*Engineer*," *August* 17, 1894.

Seventh, no matter how closely it copies some other discredited aggregation, give it a new name, and it will go for a while.

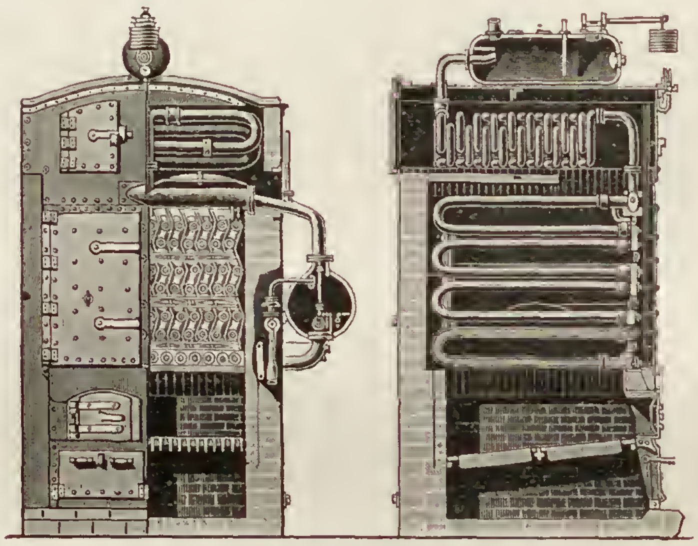


Fig. 49.—BELLVILLE'S BOILER, 1865.

Trade Circular.

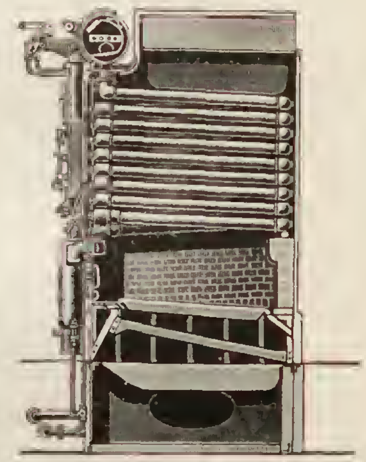


Fig. 50.—1877.

Trade Circular.

Sir Charles W. Dance, the inventor of a steam road-carriage in England, joined Joshua Field (of Maudsley & Field, the builders) in patenting the first boiler of this description (fig. 48), and can be considered the father and godfather of troubles in this line. The lower tubes were used as grates, as in Gurney's 1826 design. The familiar "up-flow" and "down-flow" pipes, connected by fittings (made specially, as there were at that time no regular ones on the market), were present. All ideas of the necessity of steam or water capacity

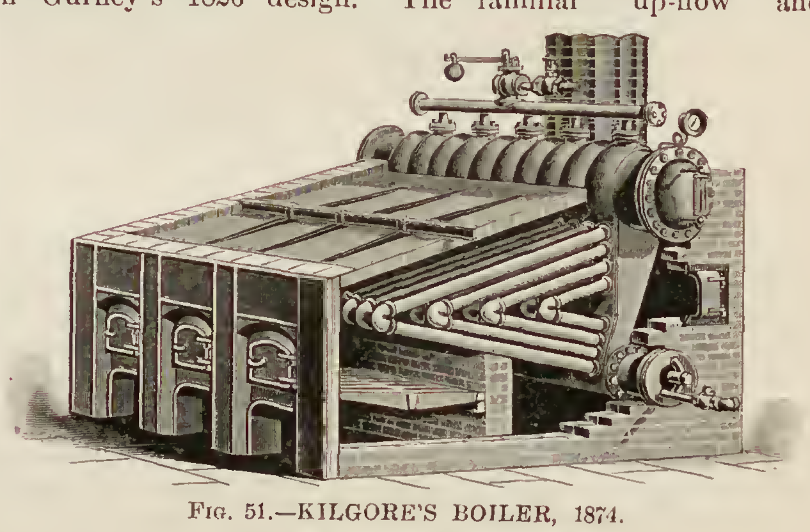


Fig. 51.—KILGORE'S BOILER, 1874.

Trade Circular Issued in Pittsburg.

* From advance sheets of a publication by the Babcock & Wilcox Co.

or desirability of access for internal cleaning were absent. Surface, weight and space occupied dominated the design.

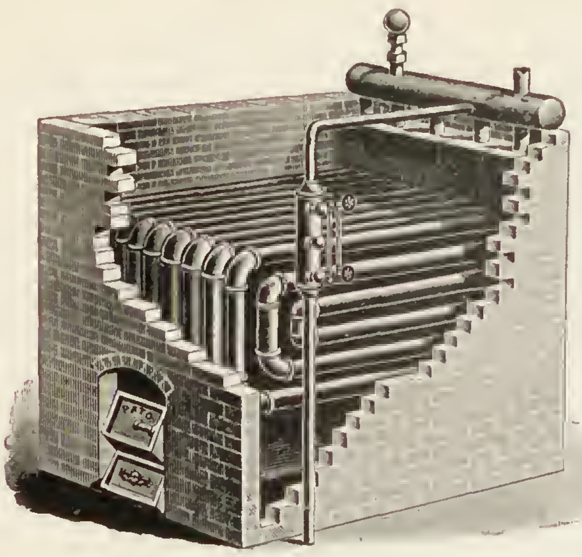


Fig. 52.—SHACKLETON'S BOILER, 1876.
Trade Circular Issued in Seneca, N. Y.

Belleville, a French engineer, introduced a box-coil boiler (fig. 49), made up of bent U pipes screwed into return bends,

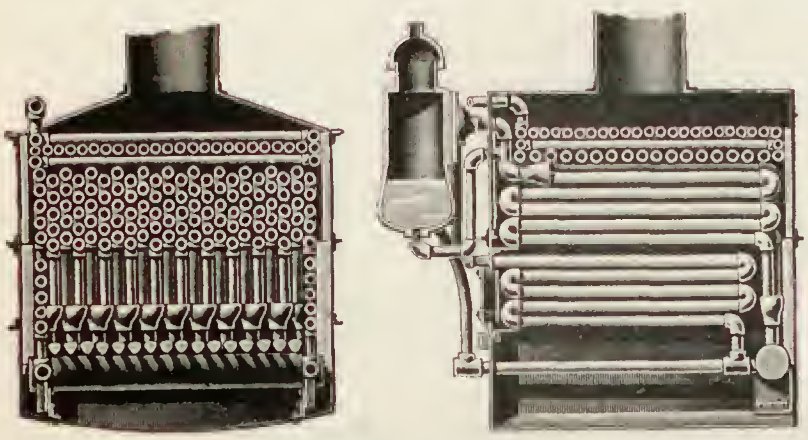


Fig. 53.—HERRESHOFF'S BOILER, 1890.
International Engineering Congress, 1894.

a series of these coils being placed vertically side by side, connected at the top to a separating drum and at the bottom to a common feed-pipe. It was fitted with various automatic

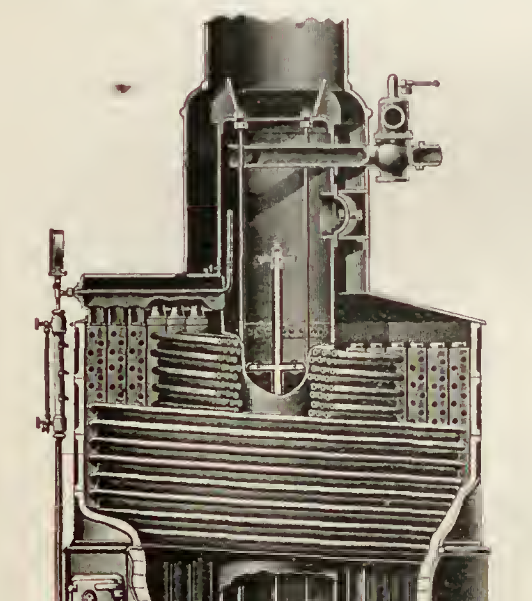


Fig. 54.—WARD'S BOILER, 1879.
U. S. Naval Reports.

devices for controlling the feed, circulation, blow-off, and pressure—the latter as it was found necessary to run the boiler at a higher pressure than that desired in the engine, throttling down to prevent the water from bodily leaving the boiler. They are used principally in marine service.

About 1877 the bent pipe was discarded and return bends used on both ends of a series of straight tubes. This boiler (fig. 50) could be cleaned by taking it all apart. One particular advantage of this boiler seems to be that the steamship owner has the opportunity to constantly displace paying freight by carrying round a mass of brick-work.

J. C. Kilgore originated the "Eclipse" boiler (fig. 51), using pipes and fittings to build up his U tube sections; otherwise it was a copy of Allen's 1872 design.

Joseph Shackleton (fig. 52) used return bend units connected to vertical manifolds, placed side by side, connected at the top to a steam collector and at their bottom ends to a common feed-pipe.

Herreshoff (fig. 53) rechristened Belleville's 1877 boiler, staggered the tubes, and added a feed-water coil above it made up in the same manner, made of pipes and fittings.

Charles Ward used a vertical cylinder surrounded by a series of concentric coils (fig. 54) interrupted twice in their circumference, on opposite sides, by vertical manifolds. These manifolds on one side were connected by a radial pipe to the bottom of the cylinder, and at the other side to a similar pipe connecting near the top of the cylinder.

E. E. Roberts (fig. 55), of New York, bred a cross between Belleville's 1877 and Herreshoff's 1890 boiler, that while

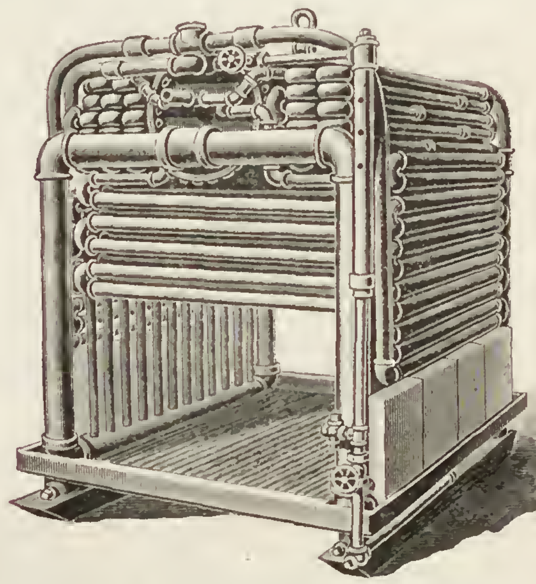


Fig. 55.—ROBERTS' BOILER, 1887.
Trade Circular Issued in New York.

"favoring" both its parents, developed outside down-take pipes of its own. Made of pipes and fittings.

Almy used straight pipes connected up with elbows and return bends to an overhead steam and water reservoir and bottom connecting pipes (fig. 56).

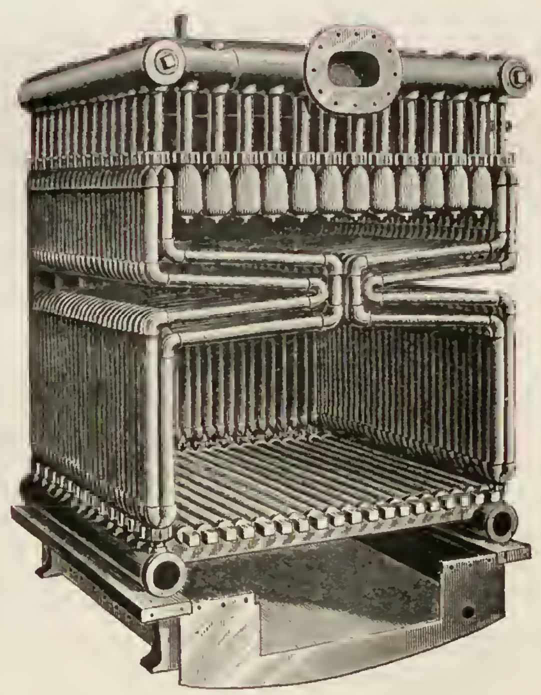
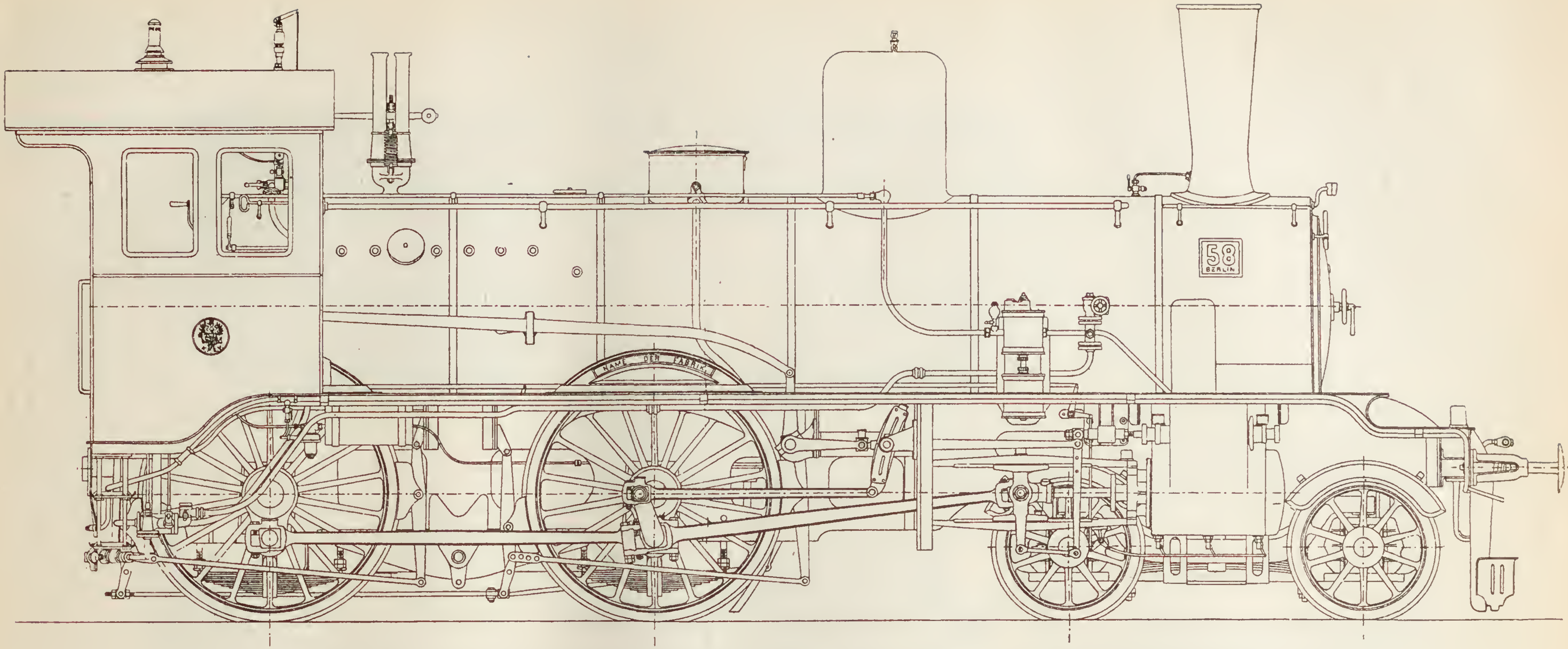


Fig. 56.—ALMY'S BOILER, 1890.
U. S. Patent No. 434,227.

The above are samples of some of the best aggregations of pipes and fittings. The least objectionable are those having the fewest bends and the least length of pipe, in proportion to the diameters used, between the inlet and outlet of each unit of circulation.



SIDE ELEVATION OF STANDARD EXPRESS PASSENGER LOCOMOTIVE FOR THE STATE RAILWAYS OF HANOVER.

EXPRESS PASSENGER LOCOMOTIVE FOR THE STATE RAILWAYS OF HANOVER.

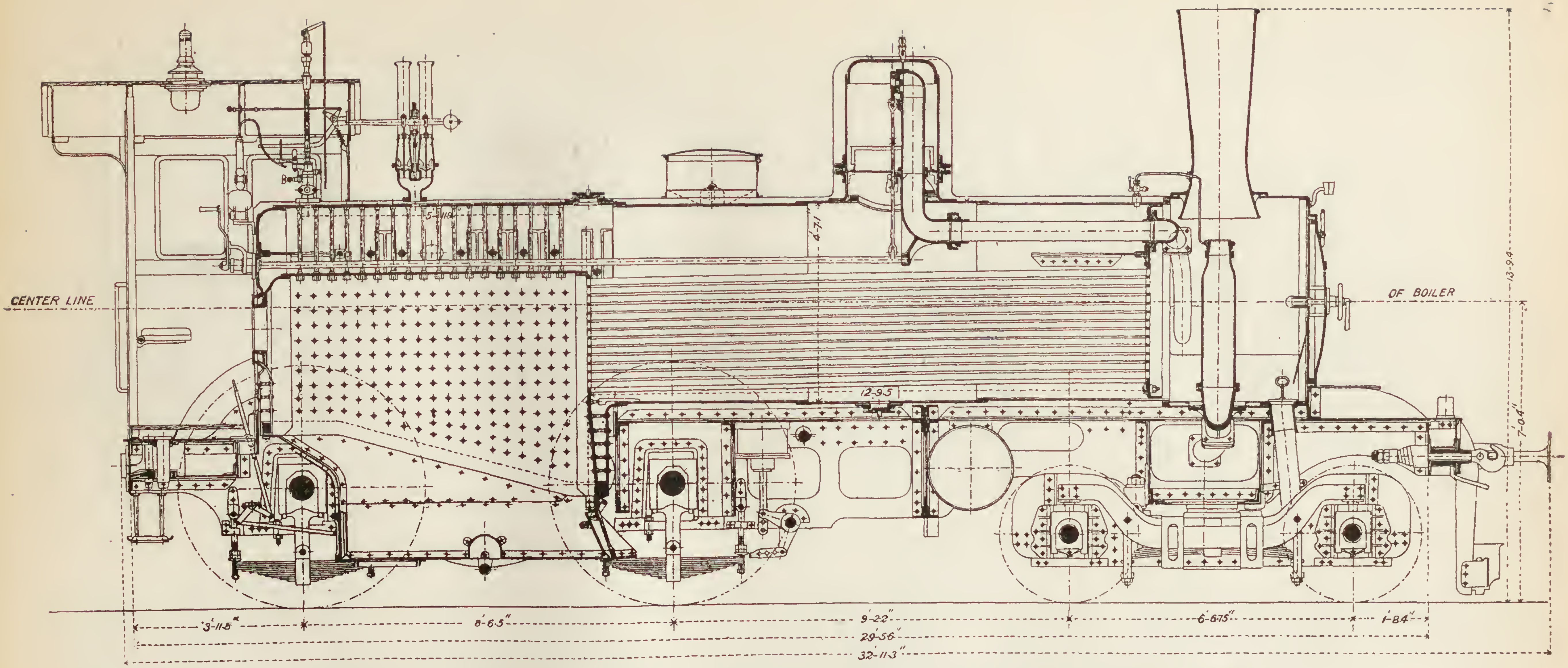
We present herewith engravings of the standard express passenger locomotive that is in use on the State Railways of Hanover. The locomotive was designed by Mr. August von Borries, the Locomotive Superintendent of the road, whose work in connection with compound locomotives is so well known. This engine is, in fact, identical with the compound locomotives in use, with the exception that the driving-wheels of the latter have a diameter of 6 ft. 6 in. instead of 5 ft. 8.8 in., as in the case of the engine illustrated.

This standard locomotive is used on roads differing widely in the character of the profile, varying from a level track to grades of 1 in 64. During the months of January and February of this year the average coal consumption on a practically level division was 37 lbs. per mile with loads averaging 110 tons. This coal consumption includes that used for the steam-heating, which was taken from the engine. The average speed, including stops and slowing-down points, is 37.28 miles per hour for local trains and 46.6 miles for express trains. The train load rating of these engines for level divisions is 240 tons, while for grades of 1 in 100 the rating is 160 tons, and for grades of 1 in 64 it is 120 tons. At full speed the engineers are expected to cut off steam at one-fifth stroke.

The wheel centres for the driving-wheels are of cast steel, and the fire-box is of copper. The engine is equipped with the driver-brakes, operated by the cylinder shown just ahead of the rear driving-axle on the longitudinal section, a shoe being placed on each side of each wheel and so interfulcrumed that all come to a bearing at the same time. The driving-springs are underhung, and no equalizer is used, so that there is something more than 6 per cent. more weight on the back driving-spring than on the forward one.

The following is a list of the principal dimensions of this locomotive :

Weight on back pair of driver springs in working order....	24,750 lbs.
" " front " " " " " " "	23,154 lbs.
Weight on truck springs in working order	27,742 lbs.
" of back pair of driving-wheels and axle........ ..	6,820 lbs.
" " forward pair of driving-wheels and axle.........	7,986 lbs.
Total adhesive weight of back pair of driving wheels in working order	21,570 lbs.
Total adhesive weight of forward pair of driving-wheels in working order	31,140 lbs.
Weight of back pair of truck wheels and axle..............	4,983 lbs.
" " front " " " " " "	4,950 lbs.
Total weight on back truck wheels in working order......	18,810 lbs.
" " " forward truck wheels in working order....	18,865 lbs.
" " " truck wheel tires	37,675 lbs.
Distance between driving-wheel centres	8 ft. 6.4 in.
" from centre of cylinder to centre of forward driving-wheel...	12 ft. 3 6 in.
Length of firebox (inside)..................................	7 ft. 2 6 in.
Width " "	3 ft. 3.75 in.

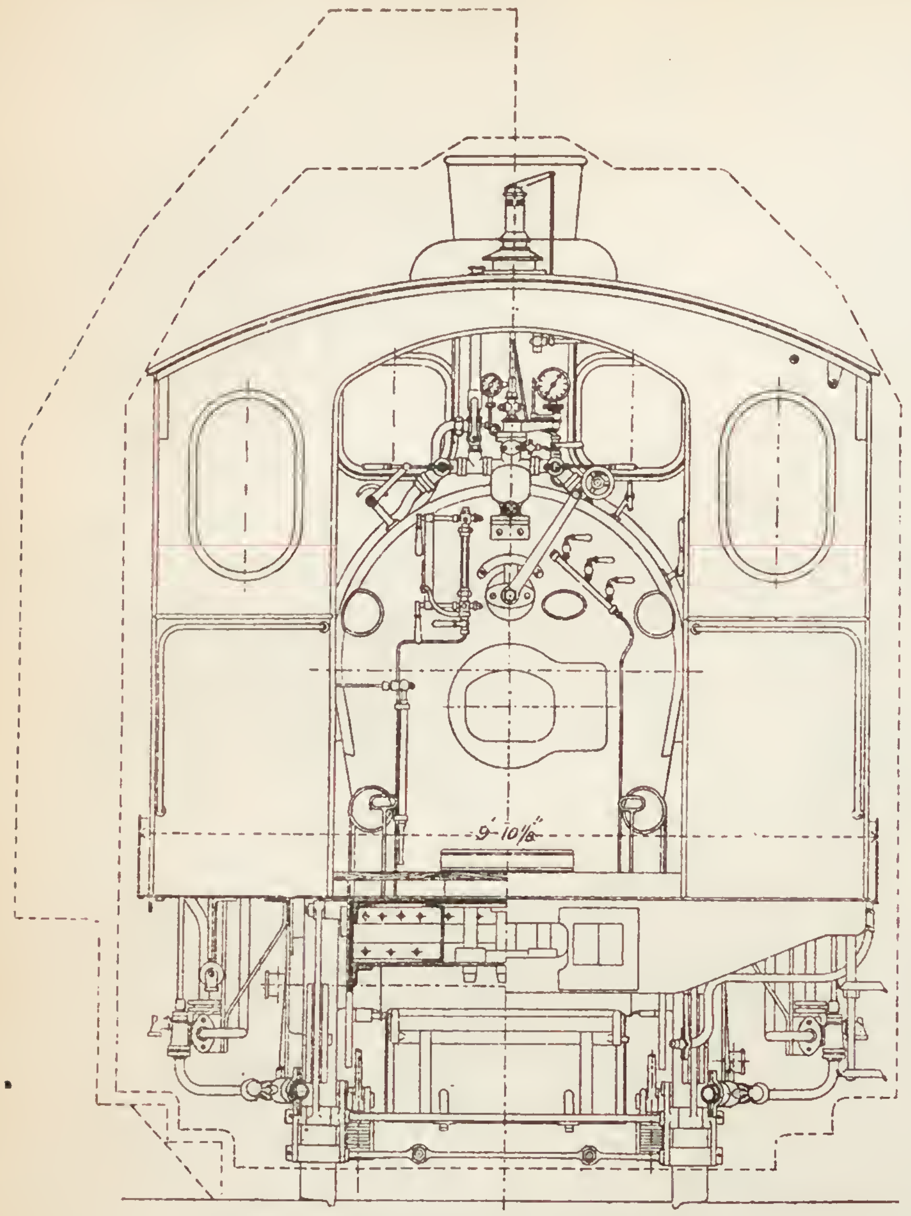


LONGITUDINAL SECTION OF STANDARD EXPRESS PASSENGER LOCOMOTIVE FOR THE STATE RAILWAYS OF HANOVER.

Depth of fire-box	5 ft. 1.8 in.
Type " "	Belpaire.
Material of inside of fire-box	Copper.
Water space, side of fire-box	2.7 in.
" " back " "	4.9 in.
" " front " "	4.9 in.
Thickness of plates outside of shell	0.55 in.
" " side sheets of inside of fire-box	0.63 in.
" " crown-sheet	0.63 in.
" " back tube-sheet	1 1 in.
" " front "	1 in.
How crown-sheet is stayed	Staybolts with head on under side.
Inside diameter of dome	2 ft. 1.6 in.
Thickness of shell of dome	.4 in.
Height of dome	3 ft. 3⅜ in.
Maximum working pressure per sq. in	180 lbs.
Kind of grate	Inclined.
Grate area	24.75 sq. ft.
Heating surface in fire-box	96.34 sq. ft.
" " " tubes	1194.30 sq. ft.

Total heating surface	1290.64 sq. ft.
Single or double exhaust nozzle	Single.
Diameter of exhaust nozzle	5.35 in. with .15 in. bridge.
Smallest inside diameter of smoke-stack	15.75 in.
Inside diameter of stack at top	19.7 in.
Height from top of rail to top of smoke-stack	13 ft. 9.4 in.
" " " " " the centre of the boiler	7 ft. .4 in.
Weight of tender, empty	34,760 lbs.
Number of wheels under tender	6
Size of tender journals	4.3 diam., 7.87 in. long.
Length of connecting-rod from centre to centre of bearings	8 ft. 2.4 in.
Transverse distance from centre to centre of cylinders	6 ft. 8.3 in.
Diameter of cylinder	18.1 in.
Stroke of piston	23.6 in.
Horizontal thickness of piston	3.94 in.
Diameter of piston rod	3 in.
Size of steam port	13.78 in. × 1.3 in.

Size of exhaust port	13.78 in. × 2.56 in.
Greatest travel of valve forward	4.78 in.
" " " backward	4.58 in.
Inside lap of valve	.04 in.
Lead of valve full stroke, front	.13 in.
" " " " back	.16 in.
Throw of upper end of reverse screw from full front to full back	14.17 in.
Sectional area of steam pipe	23.75 sq. in.
Diameter of driving-wheels outside of tires	5 ft. 8.8 in.
" " front truck wheels	3 ft. 3⅜ in.
Size of main axle journal, diameter, 7.28 in.; length	7 in.
" " truck axle journals, diameter, 5.5 in.; length	7.87 in.
" " main crank-pin journals, diameter, 4.33 in.; length	3.93 in.
" " forward side-rod journal, diameter, 2.75 in.; length	2.36 in.
" " back side-rod journal, diameter, 2.75 in.; length	2.36 in.
Length of driving springs, centre to centre of hangers	3 ft. 1.4 in.
Boiler, straight or wagon top	Straight.
Material of the barrel of boiler	Mild steel.
Thickness of plates in barrel of boiler	.55 in.

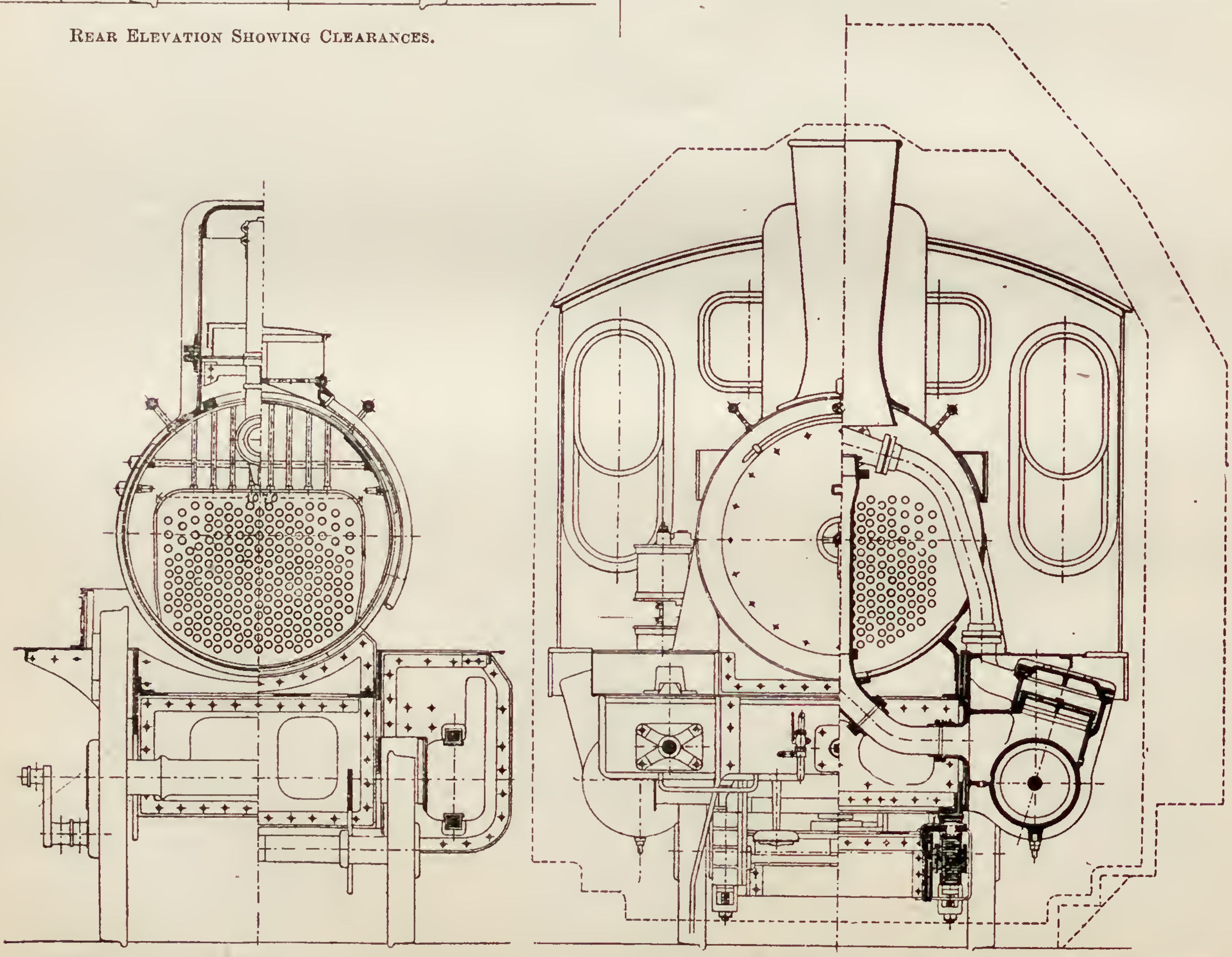


Rear Elevation Showing Clearances.

Kind of horizontal seams	Double plated.
" " circumferential seams	" rivetted
Inside diameter of barrel	4 ft. 6 in.
Material of tubes	Wrought iron.
Number " "	219
Diameter of tubes, outside	1.8 in.
" " " inside	1.6 in.
Distance between centre of tubes	2.5 in.
Length of tubes over tube plates	12 ft. 11.6 in.
Distance from center to center of truck wheels	6 ft. 6.75 in.
Water capacity of tank	3,170 gals.
Coal capacity of tender	11,000 lbs.
Total wheel base of engine and tender	43 ft. 4.65 in.
" length of engine and tender over all	53 ft. 5.5 in.
Height of centre of draft and buffing rigging above top of rail	3 ft. 5 3 in.
Length of truck spring, centre to centre	3 ft. 11.4 in.
" " smoke-box	3 ft. 4.3 in.
Height of bottom of ash-pan above top of rail	1 ft. 1.6 in.
Depth of ash-pan, front	1 ft. 5.7 in.
Number of safety valves	2 (1 Ramsbottom.)
Diameter of safety valves	2.83 in.
Distance centre to centre of buffers	5 ft. 8.8 in.
Breadth of engine at widest point	9 ft. 10⅛ in.
Height of roof of cab above top of rail	12 ft. 3.4 in.
" " " " " foot plate	8 ft. 2.2 in.
Breadth of driving wheel tires	5.3 in.
Height of running board above top of rail	5 ft. 0.6 in.
Distance from boiler head to back of foot plate	2 ft. 11.5 in.
" " top of crown-sheet to inside of boiler shell	1 ft. 6.3 in.
Transverse distance from centre to centre of driver springs	3 ft. 10.5 in.
" " between inside of driving-wheel tires	4 ft. 5.5 in.

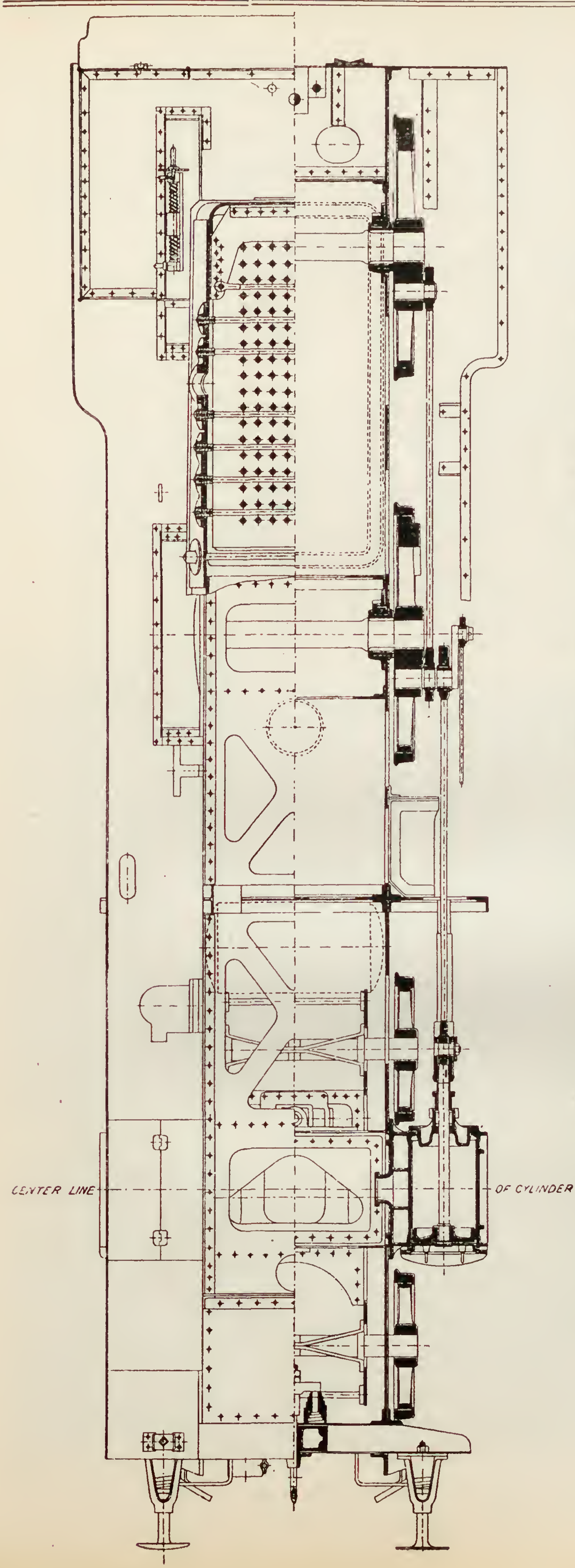
RACK RAILWAYS.

It often happens that old ideas of inventions patented many years ago, which seem to have sunk into oblivion, are, half a century later, revived under a new form, and become valuable acquisitions to the industrial and scientific world. Such has been the case with rack railways. The first rack railway was built in 1811 near Leeds, by Blenkinsop. It was a mistaken conception, if you like, but in it was, nevertheless, the germ of the invention which has made mountainous districts accessible by rail to tourists, and in many cases connected them with main lines. The engineers of the early part of the century were under the impression that the adhesion between the



Half Section at Front Driver. Half Section at Guides. Half Front Elevation. Half Section Through Cylinders.

STANDARD EXPRESS PASSENGER LOCOMOTIVE ON STATE RAILWAYS OF HANOVER.



HALF PLAN AND HORIZONTAL SECTION OF STANDARD EXPRESS PASSENGER LOCOMOTIVE ON THE STATE RAILWAYS OF HANOVER.

ordinary plain wheel and rail would not be sufficient to effect the propulsion of the locomotive, then in its infancy. Blackett, in 1811, showed that toothed wheels and racks were needless for this purpose Fifty-nine years were to elapse before Sylvester Marsh, in the United States, and Riggenbach, in Switzerland, were to revive the idea and assign it its proper place and use—*i.e.*, in those heavy gradient railways where the adhesion of the ordinary locomotive rendered it entirely inadequate to haul any load worth mentioning besides itself.

The Mount Washington Railway, built by Sylvester Marsh, is very similar to that constructed on the Righi by Messrs. Riggenbach & Naeff. It should be mentioned that Sylvester Marsh had first attempted to work Fell's central rail arrangement, but soon abandoned it, substituting for the central rail a rack. The gradients on either railway are often 1 in 4; on the average the inclination of the gradients is 11 in 50.

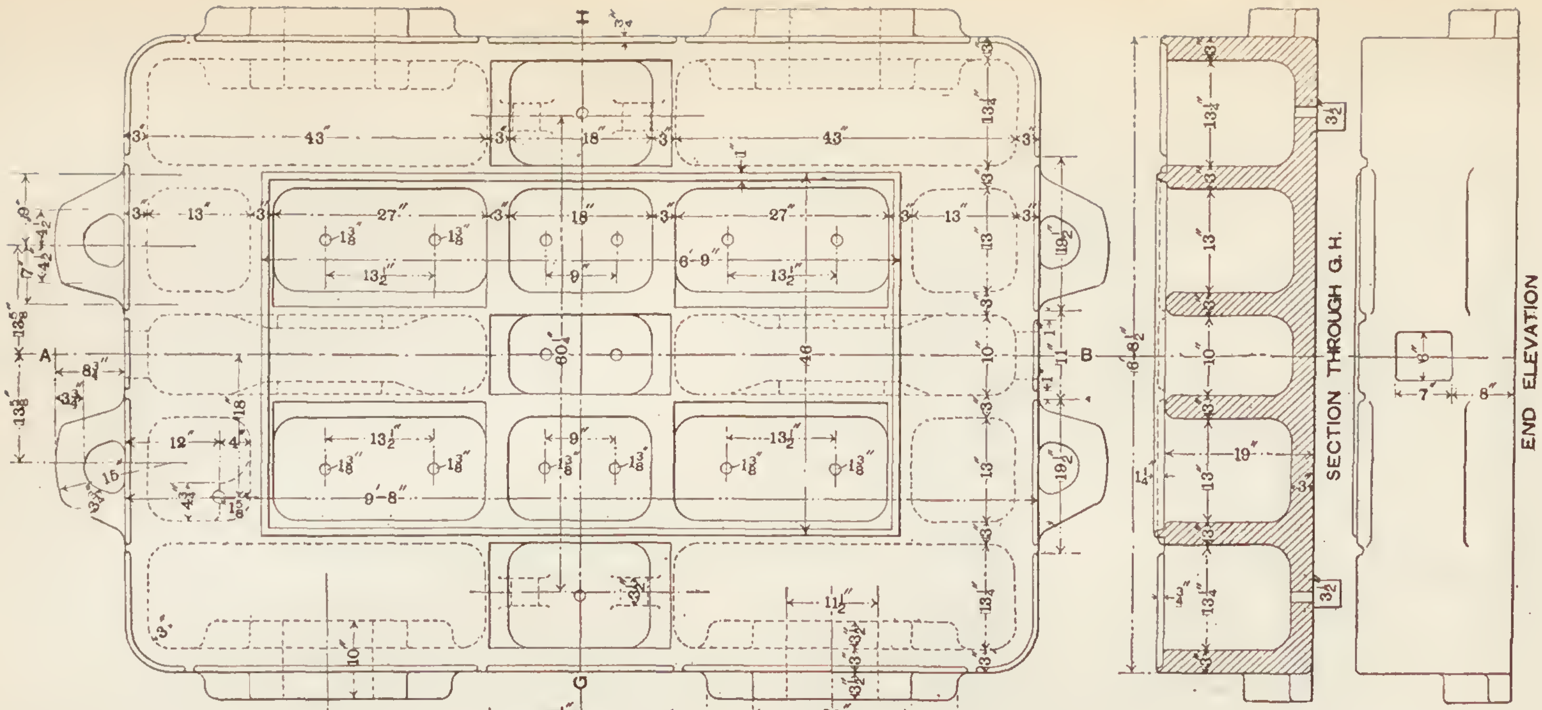
The Righi was a success, and since then no fewer than 25 lines have been built in the world on this principle. Most of them are found in Germany, Austro-Hungary and Switzerland. The aggregate length of these railways is over 100 miles. The gauge is either 4 ft. 8½ in. or 1 metre. Steep inclines of 1 in 5 are met with on the Höllenthal in Germany, and the Laufen in Switzerland.

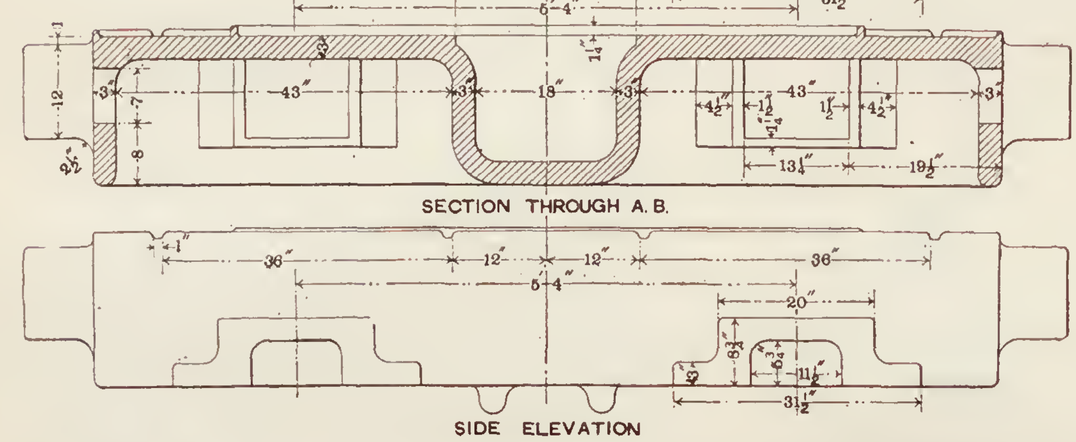
The rack used by Riggenbach is really a wrought-iron ladder laid centrally between the ordinary rails. It consists of parallel channel irons kept apart by stays of round iron, which constitute the teeth, into which gear the teeth of the wheels on the engine run. The first engine had a vertical boiler, set at an angle with the frames, so that the water level would remain horizontal, whatever the inclination of the road might be. The wheels were loose on their axles, but the toothed wheel was keyed on the middle of the rear axle. Motion was transmitted to it by intermediate spur wheels. In subsequent applications the toothed wheels were mounted on a blind axle, for in the previous arrangement it occurred that the ordinary wheels wearing on the tread would interfere with the proper working of the toothed wheel, which gears simply with the rack. In all engines built afterward horizontal boilers were adopted, but arranged in such a manner that the level of the water should always remain horizontal or nearly so.

The idea naturally occurred that the wheels which run on the ordinary rails might be coupled and actuated by steam. This has been done on nine of the railways built according to Riggenbach's plans. But the merit to have carried this new idea to its fullest extent and improved the rack belongs to M. Roman Abt, of Lucerne. During the last nine years the Abt system has made wonderful progress. No fewer than 19 railways have been built on the Abt system, representing an aggregate length of 194 miles. The longest are the Hartz Railway, in Germany, 18 miles; the Rama Serajewo, in Bosnia, 42 miles; a section of the Transandine, in South America, 31 miles; San Domingo, West Indies, 22 miles. One of these railways—that of Mont Salies, in France—is an electric one; 1 in 5 gradients, as at Aix-les-Bains, are not infrequent.

The difference between Abt's and Riggenbach's systems consists in the construction of the rack and the fuller utilization of the adhesive weight on the wheels running on the ordinary rails. There are two independent groups of cylinders. Those inside actuate the spur wheels keyed on an intermediate shaft. The outside ones drive the ordinary wheels in the usual manner, these wheels being, of course, coupled. On the portions of the lines which are not too steep the outside cylinders alone are worked; on the heavy gradients, the inside or both inside and outside cylinders are used.

The rack consists of parallel steel bars supported by chairs resting on metallic sleepers. The steel bars are cut out so as to form suitable racks, but the teeth of one bar are not opposite those of the other, but opposite the space between two teeth of it. This arrangement necessitates the employment on the engine of wheels with stepped teeth, but it reduces friction and ensures that the spur wheels are always in contact with one or





CAST-IRON FRAME FOR SCALE-TESTING CAR.

SCALE-TESTING CAR FOR PHILADELPHIA & READING RAILROAD.

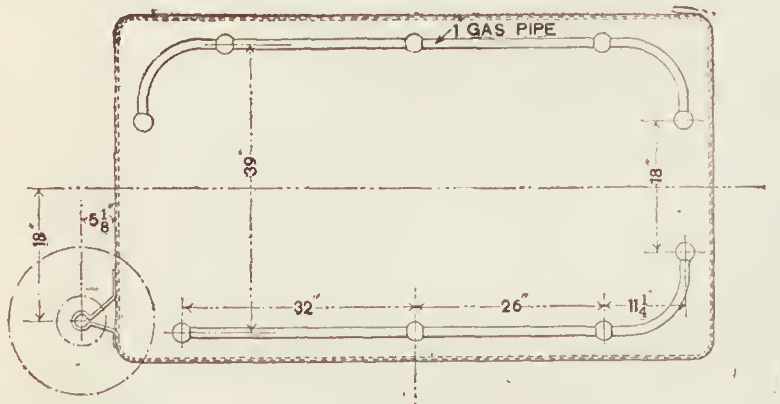
two of the rack bars, which was not the case in the Riggenbach system. The advantages are: first, the rack is easier to make and lay down with accuracy than the ladder arrangement of Riggenbach. The joints, although insistent, can for each rack bar be laid in alternate chairs, so as to keep continuity and the strength of the rack unimpaired; second, much sharper curves can be used. In the Riggenbach system they could not be less than 9 chains radius; 5 chain curves are frequent on the lines laid according to the Abt system. There is no necessity to have specially made parts for curves, as is the case with Riggenbach's rack. The slight wear which takes place on the teeth at first after the line is opened to the traffic compensates for the difference of curvature. The experience gained on the Hartz Railway goes to show that the rack teeth wear 1 millimetre in 150 years, and the spur wheels last 12 years. The Riggenbach spur wheel lasts only two years.* Third, the number of rack bars determines the weight of the trains which can be hauled on such a track; a greater speed is possible, as there are always teeth in contact with the racks, and consequently no shocks, as in the Riggenbach system. Five miles an hour on the latter gives rise to hammer blows between the wheel and rack teeth, whereas in the Abt system a speed of 15 miles an hour is obtained without shocks or noise. The Abt system has been, so far, a grand success, and it will, no doubt, receive more extended application The Beyrout-Damascus Railway, 86 miles long, will be on the Abt system.—*Railway Herald.*

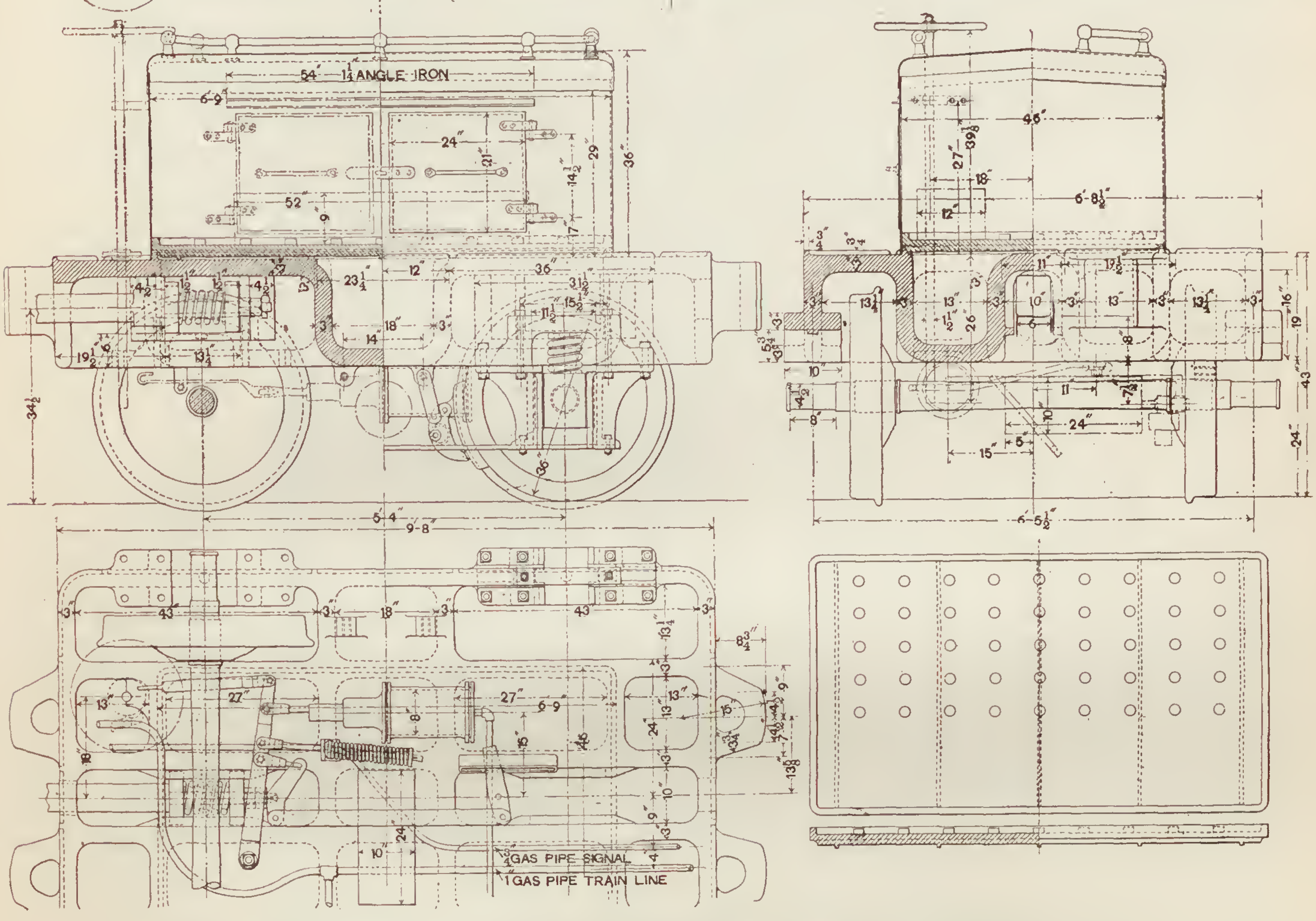
* Albert Schneider, in *Organ für Fortschritte*, for March 21, 1894.

SCALE-TESTING CAR, PHILADELPHIA & READING RAILROAD.

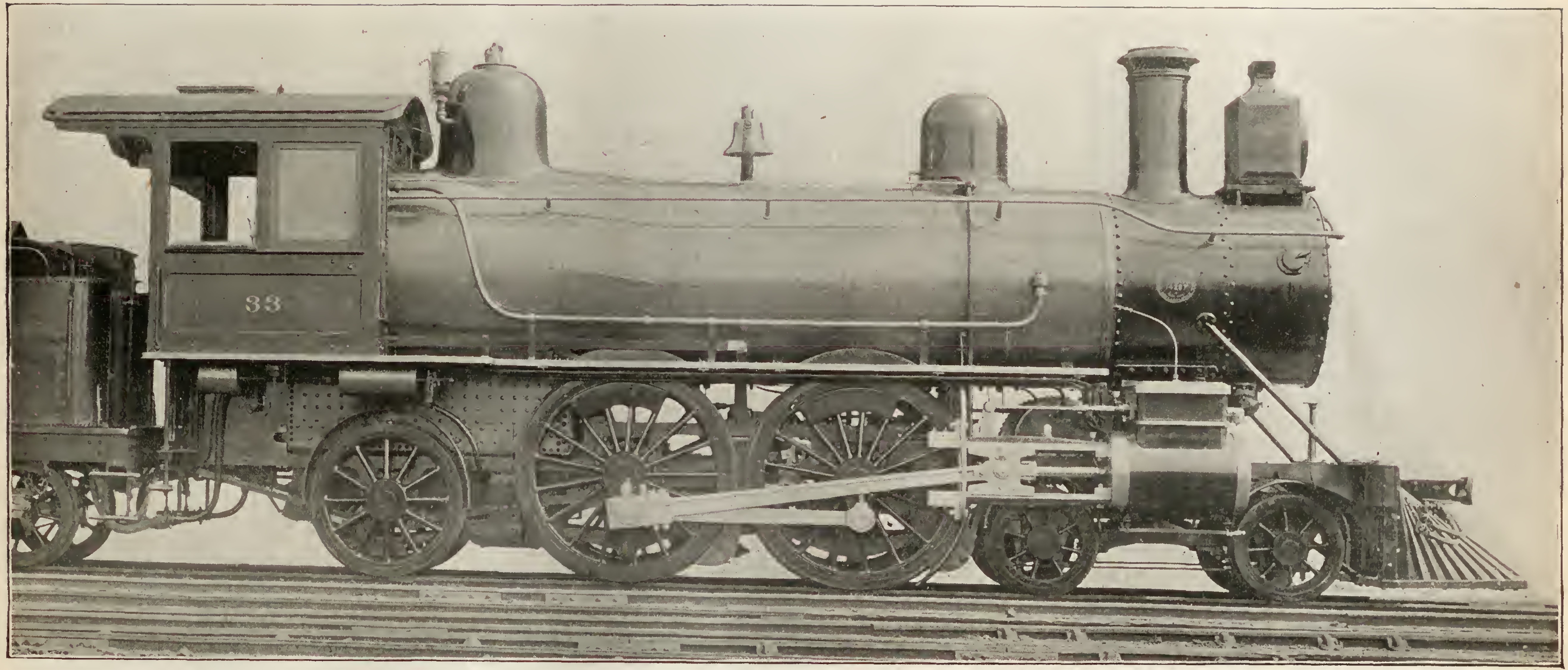
It is well understood by those who have even a superficial knowledge of weighing scales of any kind, that they are continually getting out of accurate adjustment, and this whether they are in use or not. As the coarseness of the workmanship and the loads to be weighed increase, this liability to error increases, and for accurate work it is absolutely essential that readjustments should be continually made. In order to meet this condition, the Philadelphia & Reading Railroad have built, at their Reading shops, a scale-testing car, illustrations of which are herewith presented.

The car has been in service for some time, and is giving entire satisfaction, except that it rocks fore and aft when running at the rear end of a train at a high speed. It is expected, however, that this trouble will be partially overcome by the use of stiffer springs. The body, which is shown by a separate illustration in very complete detail, is composed of a ribbed casting with metal 3 in. thick throughout and weighing 20,850 lbs. Those pockets which open to the top are filled with solid blocks of cast iron having a total weight of about 10,000 lbs. On this casting are all of the lugs and bosses required for securing the several attachments, and include the bumpers at the ends. Over the top of the body casting there is bolted a plate weighing about 1 ton, to which is riveted the heavy sheet-iron house, and which is also provided with a number of lugs that serve to keep from shifting forty-five 50-lb. weights, all scaled to U. S. standard, and which are used to test small scales. In the sheet-iron house are kept various necessary tools, extra springs, journal bearings, brake-shoes, etc., all of which are in the car when it is scaled on the standard scales at Pottstown, Pa., once every month, or oftener, if necessary. In case of the breakage of any of the above parts, the old is put into the house, and the new, taken therefrom, put into service, and the weight thus kept as near constant as possible. To the under side of the body are bolted the pedestals and brake-cylinders, the only important fixtures of the car which are not a part of the body casting. The car is carried by four 36-in. steel tired Boise wheels mounted on steel axles having $4\frac{1}{2} \times 8$ in. journals, the wheel-base being 5 ft. 4 in. The car is equipped with National Hollow brake-

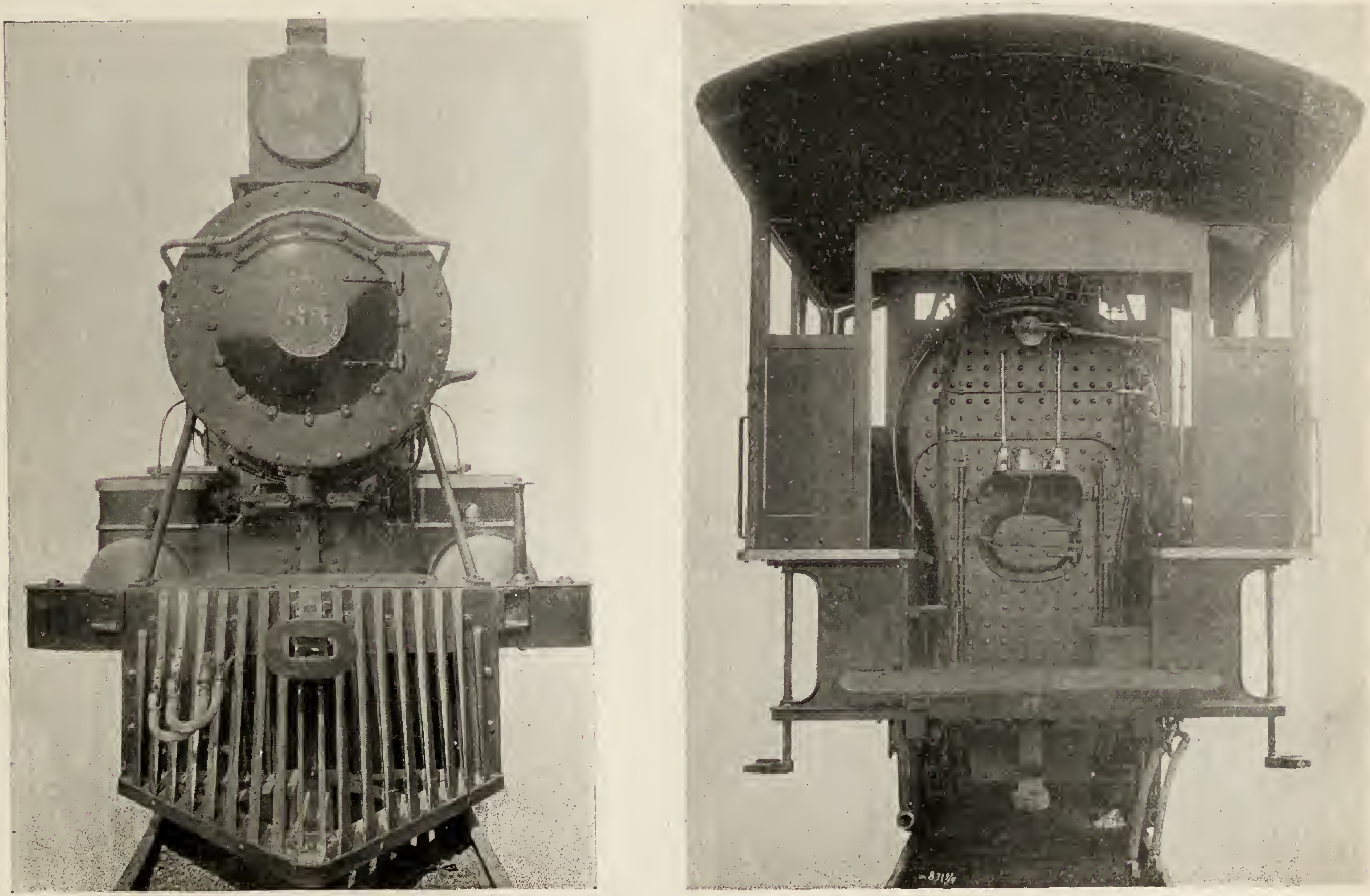




SCALE-TESTING CAR FOR THE PHILADELPHIA & READING RAILROAD.



PASSENGER LOCOMOTIVE FOR THE CONCORD & MONTREAL RAILROAD, BUILT BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA, PA.



FRONT AND REAR VIEWS OF EXPRESS PASSENGER LOCOMOTIVE, BUILT BY THE BALDWIN LOCOMOTIVE WORKS FOR THE CONCORD & MONTREAL RAILROAD.

beams, Westinghouse air-brake and signal-pipe, and the Gould automatic freight car couplers. The weight of the car when ready for service is 20 gross tons.

The half-tone reproduction of the photograph shows the car ready for service, except that the bar, which is shown thrust through the hand-wheel, is not a part of the car, and should have been removed before the photograph was taken.

PASSENGER LOCOMOTIVE FOR THE CONCORD & MONTREAL RAILROAD.

Our full-page illustration and front and back-end views represent an engine just completed for this road, which is of a design that has been recently adopted for a number of locomotives by the Baldwin Locomotive Works. The chief peculiarity consists in locating both the driving-axles in front of the fire-box, and carrying the back end on a pair of trailing wheels. It will be remembered that the engine *Columbia*, which was exhibited by this company at the Chicago Exhibition last year, was of this general type, but was compounded and had a pair of pony wheels instead of a four-wheeled truck.

The plan has much to recommend it, as it permits the driving-wheels being placed as near together as their flanges will allow, and with slightly different proportions at the back end the fire-box could be widened out to any desired width.

The following are the principal weights and dimensions of the engine :

Cylinders, diameter	19 in.
Piston stroke	24 in.
Driving-wheels, diameter outside of tires	70 in.
" " " of centres	63 in.
Driving-wheel centres of cast steel, tires held by retaining rings.	
Boiler, wagon-top.	
Working pressure	170 lbs.
Boiler, diameter	60 in.
Fire-box	89⅝ in. × 42 in.
Tubes, number	234
" diameter	2 in.
" length	14 ft.
Weight in working order, about	128,000 lbs.
" on driving-wheels	74,500 lbs.
" " front truck	31,500 lbs.
" " trailing wheels	22,000 lbs.
Total wheelbase of engine	23 ft. 5 in.
Rigid wheelbase (including trailing wheels)	12 ft. 6 in.
Spread of coupled wheels	6 ft. 1 in.
Driving axle journals	8 × 10
Engine truck journals	5 × 9
Trailing wheel journals	6½ × 10
Tender journals	4½ × 8
Diameter of engine truck wheels	33 in.
" " trailing wheels	50 in.
" " tender wheels	36 in.
Tank capacity	4,000 galls.

This locomotive is fitted with Westinghouse air brake on driving-wheels, tender and train ; Westinghouse air signal ; consolidated steam-heating appliances ; Sherbourne sander ; Columbia metallic packing ; Nathan sight-feed lubricator ; Hancock inspirators. The engine truck and tender wheels are the Vauclain wrought-iron centre steel-tired wheels manufactured by the Standard Steel Works.

MEETING OF MECHANICAL ENGINEERS.

The last monthly meeting of Mechanical Engineers in New York for the season was held on the evening of May 8, at the house of the American Society of Mechanical Engineers, No. 12 West Thirty-first Street. Mr. E. F. C. Davis, the President of the Society, presided. Mr. F. W. Dean read the paper of the evening, which was upon

THE EFFICIENCY OF COMPOUND LOCOMOTIVES.

The compounding of locomotives presents to the railroad companies of this country the greatest means of fuel economy that has been placed within their reach, and it is fair to assume that this is the greatest of all the economies that can be carried out by railroads. Long since used in engines for all other purposes with marked success, the compound principle in using steam was unused in locomotives until recently, especially in this country. Of late, however, the country has been somewhat flooded with compounds, some of very inferior designs. The result of this has undoubtedly been to cause a reaction, several compounds have been changed to simple engines, and many railroad men are either in a sceptical state of mind or condemn such locomotives in an unqualified manner. Wherever this condition exists, it can always be traced to an experience with locomotives having such bad qualities, that their use was simply intolerable. Fortunately, there are a sufficient number that are proving to be unobjectionable, and are so highly advantageous in many ways, that their continued use is assured and will be gradually extended. There is nothing in which the expression "survival of the fittest" will apply with more pertinence than to compound locomotives. Persons either possessing such exceptions or being intimately acquainted with them never hesitate to say that they are the locomotives of the future, especially for freight, elevated railway, and suburban work. A type of engine that can clearly save fully one-quarter of the coal now used by simple locomotives, that materially reduces water consumption, diminishes boiler and slide-valve repairs, reduces smoke, cinders, and the fire risk, that steams better than the simple engine in hard places, without a necessary increase of any kind of repairs, must surely become the favorite as soon as people know which design to select.

Your committee has asked me to speak particularly of the *efficiency* of compound locomotives. This I propose to do briefly and as clearly as possible, and I shall begin with a statement of the reasons why a compound locomotive that is properly designed will save steam compared with the best simple locomotive, no matter what kind of service is considered.

1. The steam can be more conveniently used with great expansion, and therefore high steam pressure can be more advantageously utilized.

2. Division of the expansion between two cylinders diminishes condensation in both cylinders by reducing the range of temperature in each cylinder.

3. Division of expansion between two cylinders renders it possible to evaporate, or re-heat, a portion of the moisture in the exhaust of the first cylinder, and thus render it capable of doing work in the second cylinder. As this can be done in the locomotive with waste gases the gain is all profit. By using the proper kind of receiver this is an effective means of economy.

4. Steam that leaks through the valve of the first cylinder is, in a properly designed locomotive, worked expansively in the second cylinder.

5. Steam that is re-evaporated toward the end of the high-pressure piston-stroke, too late to work expansively, instead of being exhausted to the atmosphere as in the simple locomotive, is worked expansively in the low-pressure cylinder.

Concerning the first reason, the expansion in the compound locomotive can be secured with a later cut-off than in the simple locomotive, and with this comes a wider port opening and less wire drawing of the steam. It is feasible to expand steam in a single cylinder by cutting off early, but such efforts have always resulted in wastefulness by great condensation, thus giving rise to the familiar expression "expansive working is expensive working." D. K. Clark showed as early as 1850 that a cut-off of about one-third stroke in a simple engine is the most economical, and the same thing has been recently shown by Professor Goss in this country. So that if a high degree of expansion is used in the simple locomotive it means extravagance in steam, although it may save some coal by low terminal pressure and gentle exhaust action on the fire. The compound locomotive, however, saves 15 to 20 per cent. of steam, and above this saves coal by its low terminal pressure and gentle exhaust.

Concerning range of temperature, in certain typical cases in my possession the temperatures and ranges were as follows :

	Simple.		Compound.		
Initial temp.	374°	H.P.	368°	L.P.	312°
Lower	230°	"	298°	"	230°
Range	144°	"	70°	"	82°

In these cases the simple locomotive used 27¼ lbs. of feed-water per I.H.P. per hour and the compound 19½ lbs., producing a saving of 29 per cent. This remarkable saving is attributable only to the small ranges of temperature in the cylinders with resultant small condensation, and to the reheating receiver, for the total expansion was the same in both cases.

In simple locomotives the condensation in cylinders sometimes amounts to as much as 60 per cent. of the total steam used, and in the case of a simple locomotive with which I have experimented, where the passages were well protected, the condensation was 38 per cent.

The effect of a re-heater is rather difficult to determine in a locomotive, and of course no rise in temperature or superheating would be shown until all of the moisture had been converted into steam. As there is much moisture in exhaust steam it is not likely that it will be all dried out by the receiver of a locomotive. In a pumping engine, however, such difficulty disappears, and in a Leavitt pumping engine at the Boston Water-Works, while the pressure in the low-pressure

steam-chest was equal to that of the atmosphere, the temperature instead of being 212° was 306°, showing the remarkable super-heating of 94°. As a compound locomotive receiver is bathed in gases of 550° to 600°, while the temperature of the moist steam within has a temperature of only some 280°, it is unnecessary to argue that some re-evaporation takes place. When we remember the great capacity of the metal of a steam cylinder to condense and re-evaporate, we have ample reason for the belief that a receiver having a temperature fully 200° higher than that of any locomotive cylinder, has a much greater capacity for evaporating moisture than a cylinder. It is clear, from these considerations, that a receiver in the smoke-box of a locomotive is of the greatest importance in promoting economy.

In the fourth reason for the economy of a compound locomotive I have stated that the leakage by the high-pressure valve should pass into the low-pressure cylinder, and there worked expansively. This is necessarily so in the two-cylinder engine, but in some four-cylinder locomotives, with a single valve to two of the cylinders, leakage may pass directly from the high-pressure cylinder, or even the boiler, to the atmosphere.

While I have pointed out the economical advantages of compounding, I must not ignore the losses to which the compound is subject. These losses have in cases converted compounds into more wasteful engines than simples.

I will take up these losses as they occur.

The first is that due to the imperfections of the link motion which are strongly brought out in the high-pressure cylinder. These imperfections are great in simple engines also, notwithstanding the protestations of some of my locomotive friends, but in the high-presure cylinder of the compound, as compression begins on the steam of receiver pressure, compression is likely to be excessive, and reduces the area of the indicator diagram seriously, and in early cut-offs at ordinary speeds, even, a loop is frequently formed showing negative work, thus reducing the net work. This is one reason why many compounds at certain points of cut-off do much more work in the low-pressure cylinder than in the high. It also furnishes a part of the reason why some compound locomotives are less economical, in relation to the simple engine, in light work than in heavy. In the latter case the point of cut-off is sufficiently late to avoid excessive compression and a loop in the diagram.

The usual remedies for this defect are, inside clearance to the slide-valve, and large clearance volume in the cylinder. The former causes the exhaust to close later, thus trapping in less steam in the clearance spaces, and the latter gives a larger volume to fill by compressed steam and thus reduces the maximum pressure. There is another remedy that ought to be applied in addition, as follows: The high-pressure valve should be set so as to give negative lead in full gear, and to give zero lead when cutting off at about 45 per cent. of the stroke. Slipping the eccentrics back sufficiently to accomplish this, delays the beginning of compression, and therefore its maximum amount.

Another loss, which is often great, is that between the cylinders, causing the combined indicator diagram to have a large gap between the bottom of the high-pressure and top of the low-pressure cards. This loss is so great in many cases as to amount to some 30 per cent. of the possible work of the steam after high-pressure release, and will nullify all gains that may come from compounding. It is probable that less than half a dozen compound locomotives in the country have this loss so small as to make it, when coupled with another phenomenon, virtually nothing. The latter will be noticed presently.

The loss between the cylinders is so insidious, so to speak, and so little comprehended, that it should be dwelt upon sufficiently to make its causes and nature clear. It cannot be done away with, even in slow-running pumping engines, for even there some work must be absorbed in transferring the steam from one cylinder to the other. In addition to this cause the various resistances produced by obstructions and abrupt changes in direction of the steam passages are to be noted. The steam in passing out of the first cylinder, through the intercepting valve, where this is used, and through the open port of the low-pressure cylinder, is considerably retarded and a great loss of pressure is produced. Engines having piston-valves suffer much from this loss because the steam has to pass through gratings which form the ports. Engines that have the intercepting valve on the low-pressure side are much subject to this loss, because the steam is rapidly drawn from the receiver by the low-pressure piston through this restricted opening. If this valve is on the high-pressure side the steam passes through it only as rapidly as it escapes from the small cylinder, and this is only some one-half to one-third as rapidly as it is drawn into the large cylinder. This shows the importance of placing the intercepting valve as near the high-pressure cylinder as possible.

The type of engine that can be used at will as a simple engine, is in general considerably subject to this loss, for the changing valve forms tortuous passages and abrupt obstructions when the engine is compounded. In this case also, the valve should be near the high-pressure side.

I should not omit to notice a loss seldom thought of—viz., that due to the back pressure on the low-pressure piston. This piston always has a larger area than the combined areas of the two pistons of the equivalent simple engine. Unless the back pressure per square inch on the low-pressure piston is less than on the simple pistons, in proportion to the greater piston area, it is evident that the work of the back pressure is greater in the compound than in the simple engine. In general, I think the back pressure will be found to be proportionately less than in the simple engine, but this possible loss should furnish caution against over-cylindering a compound locomotive, especially on the low-pressure side, and particularly for high speeds. This is an argument for obtaining large power by means of large high-pressure cylinders, and indirectly for the cylinder ratio of 2 to 1, or thereabout, for a passenger engine.

Having considered all the losses to which a compound is subject, we are in a position to appreciate the reason why certain compound locomotives are highly economical, when working slowly or even moderately fast, with heavy trains. In these cases in consequence of late cut-off, yet with considerable expansion, and somewhat slow movement of the steam, the losses described are small, and bear a small proportion to the total work done. The result is that the compound is enabled to bring out those valuable qualities undiminished, which in numerous cases it has proven itself to possess.

Most compound locomotives have a low-pressure port ridiculously small, so small, in fact, that, while simple engines require an extravagant velocity of steam through ports, even as high as 1500 ft. per second, some compounds have it two to three times as great. In such locomotives the loss between the cylinders is enormous, and the engine becomes useless for high speeds.

The compensation for the loss between the cylinders, to which reference has been made, is the increase in the area of the low-pressure diagram, produced by the fact that compression should occur only up to the initial pressure in that cylinder. The late exhaust closure fills out the heel of the diagram and may add to its area the amount lost between the diagrams. In my experience the loss between the cylinders at 232 revolutions per minute was only 8 per cent., while in many compounds at this speed it is fully 30 per cent. The above 8 per cent. was exactly made up as just described. In the same case the cards realized 87 per cent. of the theoretical isothermal card having the same ratio of expansion and back pressure, and this was fully as much as a simple engine realized under the same conditions. Such a result is remarkable for a compound engine even in stationary service.

This discussion has brought out the fact that the compound locomotive is subject to losses to which the simple engine is not, and which may render it unfit for fast work. Such defects can, however, be fully overcome by large and easy passages, and the oft-repeated statement that the compound is fit only for freight trains is highly erroneous.

From one point of view compound locomotives can be divided into two classes—viz., the automatic, that starts by allowing live steam to pass to the large cylinder only until the engine has made a half revolution or thereabout; and non-automatic engines, that can be operated at will as simple locomotives as long as desired.

I have always taken the position that the non-automatic engine does not allow the compound system to fully realize its object, and that any locomotive which does not immediately become a compound after making an initial movement is to some extent a failure.

It is held by the advocates of this type that the automatic engine does not start well, and that it cannot pull a sufficiently heavy train over ruling grades. Neither of these features has come within my experience, although that has been with freight trains on a continuous grade of 96 ft. per mile, 12 miles long, and with heavy fast suburban passenger work with 11 stops in 9 miles. It is no exaggeration, in fact, to say that the starting of the automatic engine has been uniformly surer than that of the simple engine in this service.

The point here considered is of the greatest importance in suburban or elevated railway work, for here the compound is particularly economical if it is a compound from the beginning. If it is a simple engine for some little time, the greatest part of its peculiar adaptation to the work which requires frequent starting is lost. This will be referred to again.

From another point of view, compound locomotives are divided into two, three, or four-cylinder engines. Here appears a radical difference in detail, and one that must not be passed over without discussion.

In designing an engine for any kind of work it is fundamental that the smallest cylinders that will properly expand the steam should be used, and that the smallest number of cylinders should be used. By pursuing any other course more cylinder, piston, and piston-rod surface is obtained than is necessary. As cylinder condensation is the greatest of all enemies of economy, by using multiple cylinders we invite our greatest enemy to be always with us. It is at least approximately true that cylinder condensation is proportional to surface, other things being equal, and dealing with common sizes, the cylinder, piston, and piston-rod surfaces of a four-cylinder compound engine will be found to be about 33 per cent. in excess of those of the two-cylinder type. It is evident that the four-cylinder compound is therefore very seriously handicapped, when competing with the two-cylinder compound.

No further logic should be necessary to show that the four-cylinder compound cannot be justified from an economical standpoint, and has no reason for existence except as a means of producing a balanced engine.

If a two-cylinder compound requires a larger low-pressure cylinder than can be accommodated, two low-pressure cylinders can be used in its place, cast together, one above the other, and yet with advantage over the four-cylinder engine.

I now wish to consider the various kinds of railway service with reference to the economy of the compound locomotive. Assuming that the compound is of the automatic type, the order of economy is as follows, the greatest being first:

Elevated city railway service; suburban railway service; freight railway service; express passenger railway service.

The economy on the elevated railway is due to the great amount of starting and acceleration of trains. The simple engine can only do this when working steam at full stroke or late cut-offs, while the compound engine will expand the steam some two and one-quarter times when starting, and much more soon afterward. Bearing in mind the great economy of steam gained by the early stages of expansion, the economy of the compound is evident. The following table shows the relative values of a pound weight of steam at different points of cut-off:

POINT OF CUT-OFF.	VALUE OF 1 LB. IN WEIGHT OF STEAM.
Full stroke	1.000
$\frac{1}{2}$ "	1.659
$\frac{1}{3}$ "	2.000
$\frac{1}{4}$ "	2.207
$\frac{1}{5}$ "	2.343
$\frac{1}{6}$ "	2.435
$\frac{1}{7}$ "	2.495
$\frac{1}{8}$ "	2.532
$\frac{1}{9}$ "	2.552
$\frac{1}{10}$ "	2.560

This table shows that when the simple locomotive starts, it is using steam in such a way that 1 lb. in weight does work of a value of 1, while the compound obtains from the same weight of steam work represented by 1.659 at least. In most cases it will be more than this, say 1.768 for $2\frac{1}{4}$ expansions. The saving in steam is therefore $\frac{1.768 - 1}{1.768} = 43$ per cent.

Soon after, the simple locomotive is expanding the steam twice and the compound fully four times. The steam quantities are then 1.659 for the simple and for the compound 2.207. The saving in steam is then $\frac{2.207 - 1.659}{2.207} = 25$ per cent. The actual savings made by some compounds in elevated service show that these figures are not far from the truth.

In express passenger service the quantities would be somewhat thus:

$$\frac{2.435 - 2.207}{2.435} = 9 \text{ per cent.}$$

The remainder of the saving in steam would come from the other causes mentioned in this paper, but chiefly from reduced cylinder condensation.

If we add to this effect the economy due to reduced cylinder condensation, and diminished ejection of sparks from the stack, the economy of the compound is still more marked, and it is evident that in elevated service the non-automatic compound loses a great part of these advantages.

Following out this reasoning the order of my list of services will be justified. Unfortunately if the simple locomotive uses the upper grades of expansion, some 40 or 50 per cent. of this steam will be condensed in the cylinders.

The saving of fuel by the compound locomotive is materially affected by its increased evaporation per pound of coal, which amounts to some 15 per cent. Added to this a saving of some 15 per cent. in steam consumption, it appears an easy matter to save 30 per cent. in coal.

In closing, I desire to refer to the claim made by many persons that the saving by compounds is due to larger boilers and higher pressures. There have now been so many trials of engines of both types with boilers and pressures the same, that this view is gradually being abandoned. I have myself conducted trials of simple locomotives with pressures of 140 lbs., 160 lbs., and 175 lbs., and have been unable to perceive any material difference in water consumption. Perhaps the most conclusive trials of this character were carried out by the Caledonian Railway in Great Britain, where the same engines have been tried with pressures varying from 150 lbs. to 200 lbs., over long periods in the same service. I have been informed by the late Locomotive Superintendent of that line, that their conclusion was that the most economical pressure for a simple locomotive is from 150 to 160 lbs.

The grand fact to remember in all of these considerations is that the compound locomotive can use as little as 20 lbs. of steam per hour per I.H.P., while the simple locomotive cannot use less than 27 lbs., and in passenger work such a result for the compound can be attained by avoiding a net loss of work between the cylinders.

DISCUSSION.

Mr. Nichols: I have been very much interested in compound locomotives, and also in what Mr. Dean has said. He speaks of the advantage compound engines have for elevated service. They, of course, appeal directly to the elevated railway; first, from the practical standpoint of a lesser amount of dust and ashes, smoke, steam, etc., emitted, from the fact of using half the number of exhausts, and not only from that, but from the fact that these exhausts are emitted at considerably reduced pressures, certainly not more than one-half that of simple engines. The result is less trouble to people alongside of the road and less noise. It might seem rather strange that the subject had not been more generally taken up, therefore, by elevated railroad people, because of these advantages, in addition to the greater advantage of economy in fuel, which now has been thoroughly demonstrated in favor of the compound engine. Of course, there are many reasons why that has not been done. The same reasons, I suppose, would apply to prevent the adoption of electricity or something that might be better than steam—that is, in other words, the objection that it costs a great deal to make any change; and railroad managers, particularly elevated railroad managers, are specially conservative in making changes of this kind. In 1890, I think, three engines out of 75 were changed from simple to compound. These three had been wrecked. They were originally Rhode Island engines. They were rebuilt by that works then and made compound engines; they have been in continuous service ever since, running side by side with simple engines of the same class and capacity. The cylinders, which had been originally 11 in. in diameter, were made, on the high-pressure side, $11\frac{1}{2}$ in. in diameter, and the area of the low pressure was 2.4 times the area of the high pressure. Those engines had no increase in boiler capacity, no increase in any of the parts, no material increase in the weights. I lay stress on this for what I am coming to later. The experience with these three engines was so satisfactory, for the reasons spoken of—less vexation to the passengers and to residents along the line and decided economy—that it led in 1892 to the construction for new work of 19 other engines, all of them two-cylinder compounds, 16 of them built by the Rhode Island Works and three built by the Pittsburgh Locomotive Works; the Rhode Island locomotive engines being the automatic engines that Mr. Dean has spoken of—that is, changing from simple to compound; and the Pittsburgh engines being of the non-automatic type, requiring to be changed from simple to compound. The old engines weighed 24 or 25 tons. The new engines were made heavier, and weighed 28 to 29 tons. This was done because we were determined to use five-car trains, and wanted to make sure of them on the absurdly heavy grades which, unfortunately, obtain in all cities.

Now as to the result. Some observations of these particular engines, made soon after they were on—I compare now the new compounds with the old simple engines—and on several runs that were made, the average of these I give for the simple engine drawing a four-car train loaded. The starting time—that is, from the time of getting up to full speed—averaged

28 seconds; the time of run between stations at full speed, 44 seconds; the slowing down, 18 seconds, and the standing time at the stations, 11½ seconds. For the compound in the same service, same weight of train, etc.: Starting time, 28 seconds; full speed, 38 seconds; slowing down, 21 seconds, and the standing at the stations, 11⅔ seconds. The standing at the station, simple or compound, had nothing to do with that, because that depended more largely on the facility for passengers getting in or out. The compound reached full speed quicker than the simple. Our anticipation had been, and it had been predicted by opponents of the compound engine, that there must be trouble with compounds in this respect—that they would start more slowly, and that they would come to a stop more slowly than simple engines. But the opposite was proven in these cases. On the other hand, we noticed that the simple engines slowed down in 18 seconds and the compound in 21. That was due largely to the fact that the compound engines were heavier than the simple engines were, and that they used the air brakes only, and had not the Westinghouse brake. I think it is entirely attributable to that—that the engineers would hesitate with a heavy train to slow down for fear of causing disturbance to the passengers. So that the advantage seemed to be on these runs on elevated railroad service just where it was predicted the engine would not succeed. It seemed as though they had succeeded to the fullest anticipation. The time of this run, which was 4.22 miles, was 22.8 minutes for the simple and 20.2 for the compound, or averaging 12.1 miles an hour, including 11 or 12 stops for the simple engine and 12½ for the compound. This speed was afterward increased. When that run was increased to 6 miles it was determined to speed the engines up more, and an average of 15 miles, including the stops, was maintained with the compound engines, and we never did have a simple engine that would maintain that 15 miles an hour and make the 19 stops in the 6-mile run. That is partly due to the weight—the compound would always do it. The result is substantially this—I make the claim mildly—I know that we are saving 20 per cent.; and some claim—the Rhode Island expert, Mr. Batcheller, now deceased, who designed the engines, claimed, and demonstrated to his satisfaction, and I think to mine, that he was making a saving of nearly 30 per cent. in fuel and in water; but I claim merely 20 per cent., and our average practice will show 20 per cent. saving, or it will show that those engines are annually saving 20 per cent. of the cost of the engines in the use of fuel and water; and that becomes very important, particularly on elevated service, where our fuel and water approximate to 25 per cent. of the total expenses of operation.

There was a great deal of criticism made as to these engines, and there was an unfortunate time in 1893 for the engines, in which year I am a little afraid the four-cylinder type was favored more than these. The effect was that the whole of these 19 engines were laid out of service for upward of six months. It was decided that they were not satisfactory, and that they were giving us a great deal of trouble. The nature of that trouble was this: that there was a disagreeable jolt in starting and stopping those engines, so as to disturb persons in their seats. A great deal of time and attention was given in trying to find out what that was attributable to. I never was fully satisfied in my mind what the trouble was. The fact, however, that these things did occur led to careful observation of it, and I have observed the matter carefully and come to the conclusion briefly that the compound engine requires a great deal more care given to important details. It requires a great deal more care and attention in its repairs, in keeping in order, and probably considerably more expense than the simple engine; that it requires—I speak now of these two-cylinder engines—it requires a great deal more care and skill in running, particularly in elevated railway service. I have seen runners make four and five stops without disturbing a person any more than you would be disturbed in sitting in a chair here, and then on the sixth or seventh stop bring the train up with a jolt that would almost throw you on your head, showing at once, the engine being on the same run, that there must be a great deal of it in the individual runner; and that became so impressed on my mind that, although I hesitated a long while about it, I was almost determined that it was very largely prejudice on the part of the men—that they were determined not to run those engines smoothly. That is a pretty severe accusation to make, I know; but it leads to this general result, from my standpoint: that I would not advise using compound engines in connection with simple ones, or the reverse, you may say, because if men become accustomed to one type of engine it is difficult for them to become reconciled to another type; and the simple engine requires a little less knowledge to understand. The runner does not need to know about the intercepting valve. The result is, he avoids it and does not use his best efforts to make it do its best work. I think a great deal of our trouble with compounds has been due to that. I have never heard or known of a case where the three original compounds—changed over, mark you, from simple into compound, and therefore not specially designed as compounds, and those three compounds are running side by side with the simple engines—I have never known or heard of a case in which those engines ever jarred a train, so I think it almost conclusive proof of what I said.

Mr. Dean's reference to superheating has a significance, to my mind, because a friend of mine, quite a skilful engineer in the city and rather an opponent of compound principles, said that he thought the steam gap in the smoke-box of the two-cylinder engines was quite enough to correspond with about 20 per cent. gain, and was disposed not to ascribe anything further to the compound principle; but he was finally, after discussion, induced to state that he believed that would not amount to more than about 10 per cent., and to acknowledge that there must be something like 10 or 15 per cent. saving in the compound principle itself from other causes.

Mr. Platt: I would like to ask for information, from these gentlemen who are familiar with the compound locomotive, upon this question: Given two roads about the same length but of very different characteristics—for instance, take the Hudson River Road from here to Albany, about 142 or 143 miles, and the Delaware, Lackawanna & Western to Scranton, about the same distance, one being practically level, and the other having a rise of somewhere about 2,000 ft. above tide water, besides the very irregular grade between here and the Summit, the Summit being about 110 miles from here, and then falling 1,200 ft. into the valley—would you expect anything like the same economy on such an undulating road as you would on a road like the Hudson River?

Mr. Dean: I think perhaps I can say something on that subject. I should not expect quite the economy; only, however, from one standpoint, and that is that the engines between here and Scranton would have to run down hill considerably, and they would be burning coal while running down hill, and therefore they would not have the opportunity to be saving during that time. But, on the other hand, while they were climbing the hills they would be saving more than they would if the road was like the Hudson River; so that possibly they might come to be saving fully as much, and I rather think more than they would on a level road, because the compound produces marked saving in climbing hills. But on the Lehigh Valley Railroad, where an engine of my design is running up the 96-ft. grade out of Wilkesbarre, the service is peculiar and the saving cannot be as great as is found in many other places, for the reason that the engine pushes a train of coal cars up to the top of the grade and then comes down empty; then turns around and pushes another train up the grade, so that in 24 hours, even by working pretty late in the evening, they can go up that hill three times—and it takes about an hour to go up—and they would be saving coal during three hours—it is anthracite coal—and burning it during the rest of the 24. In the actual case where this engine was tested against the best simple engine they had—of course that is always the case; where there is one compound it is always put against the best simple engine—the actual saving in coal was a little over 16 per cent. and in water over 13 per cent. But where the engine was taken down on another division which was nearly level the saving in water was 25 per cent.

Mr. Vauclain: I think, Mr. President, that the economy that we could expect from the compound locomotives operating under those conditions would depend almost entirely on the manner the locomotives would be loaded. If the engines were running at the same point of cut-off in both cases, we would expect the same economy from the engine so long as it was under speed. If the engine were loaded to its most economical point of cut-off on the level, and was using steam constantly from one end of the road to another, we would certainly obtain a much better result on a level road. On a hilly road we would have to load our engine so as to be able to haul the train on a maximum grade. Therefore on certain portions of the road the engine would be operated at slight disadvantages—that is, there would not be the same economy as if the road were uniform. In addition to that, the drifting of the locomotive would be simply permitting that engine to waste fuel in order to maintain the pressure, so that the steam would be available when they wanted to make use of the engine.

The locomotives upon the Pike's Peak Railroad were first constructed as single-expansion engines. The road is about 9 miles long. The maximum grade is 25 per cent. The minimum grade is about 7 per cent. The engines did fairly good work. They were very well satisfied with them. But the consumption of water was enormous, and also the consumption of coal, necessitating several stops for water and fuel, and prolonging the duration of the trip, so that the runs were not very

profitable. The business of the road, however, increased to such an extent that it became necessary to have another locomotive ; and as I had taken the trouble to go there and set the single expansions up, they consulted with me as to what I thought would be the best type of engine to buy—whether I would advise the use of compound locomotives. I said I certainly would, and that we would guarantee that the performance of the compound engines would be superior to that of the single-expansion engines. Under those conditions we built them a compound locomotive of the same capacity as the single-expansion engine, and the economy in fuel was about 35 per cent.—from 35 to 38 per cent. The consumption of water was about 25 per cent.—between 25 and 28 per cent.—necessitating one less stop for water and one less stop for fuel. The speed of the machine going up the hill was also increased. We reduced the time from about two and one-half hours with the single-expansion to one hour and 50 minutes with the compound engine. This performance was so satisfactory to this road that after one year's use of the compound engine they negotiated with us and arranged to have the three single-expansion engines returned to the works and converted into compound engines, and now the road is operated exclusively by compound locomotives, and they would have nothing else.

There is still another point in connection with these locomotives on the Pike's Peak Road. It is a very easy matter to get up to the top of the mountain ; but after you are up there it is not such an easy matter to come down again. You cannot use ordinary power brakes and come down a 25-per cent. grade. It is simply like sliding down an ordinary cellar door. The manner in which we get down hill is to convert the cylinders into air brakes. We use them as an air brake, or what is ordinarily termed a water brake. We lead a jet of water into the exhaust passages of the cylinders and throw the engine in forward motion, and let it drift backward down the hill. We have the exhaust passages piped up and a regulating valve on the pipes, so that we can reduce the air pressure in the cylinders and steam-pipe passages to any desired pressure that we see fit, and we find that this system of braking is very much more effective on a compound engine than what it is on a single-expansion. The engineers have very much greater control over their trains than they formerly had with the single-expansion engines. The locomotives are four-cylinder compounds.

Mr. Platt: I would like to ask Mr. Vauclain, when he gets up again, to explain the difference between the operation of those engines coming down the hill and the ones on the Rigi Road. I noticed a very different sound coming down the Rigi from coming down Pike's Peak. My recollection is that in the Rigi there is just as much of an exhaust coming down the hill as going up, one being exhausted with compressed air, the other being exhausted with steam ; but that there was no exhaust at all on the Pike's Peak Road. I was out there in October, but I have not been on the Rigi since 1881, and I would not undertake to say that those engines are there now.

Mr. Vauclain: I think that the noise in the Rigi engines is perhaps due to letting go of the compressed air in the smoke-box. With the ordinary locomotive, when you are running along, if you reverse the lever the engine will take in air and throw it out again in the smoke-box, causing a noise similar to that of exhaust steam ; whereas on our system of water brake we pipe the exhaust back to the cab of the engine ; we put a regulating valve on there with a muffler. We lead the air out under the cab at the back end of the engine where it is unnoticeable If any one sees fit to ride on the locomotive, he can hear this air escaping out of the muffler very quietly. They are somewhat similar to the mufflers used on the elevated locomotives here with their Eames vacuum brake. But when it is thrown out into the smoke-box it makes a noise similar to the exhaust. We found it more satisfactory to seal the exhaust, so we have a valve which fits into the exhaust port ; when the exhaust is closed to the smoke box it is open to the atmosphere underneath, so that nothing but good clean air can be taken in.

When I received the invitation from the committee to come here and speak for five minutes on compound locomotives, it was with considerable hesitation that I made up my mind to come. Being the patentee of one of the most extensively used systems of compound locomotives in this country, I have a slight hesitation in speaking about them before an association of this kind ; I might be accused of taking advantage of the opportunity to advertise my wares. I naturally am favorable to the four cylinder compound. I do not wish you to understand that I take the position that two-cylinder compounds are no good. I believe that a great deal of the trouble that we have experienced with the two-cylinder compounds in locomotives in this country and abroad has been due somewhat to the faulty designing and not sufficient engineering skill having been spent upon the designs when the engines were worked out. In this country locomotive builders are apt to take an order for a locomotive and build it very rapidly. It is impossible to build satisfactory compounds upon a basis of that kind unless you have gone through the experimental period and understand exactly what you are doing and know just what to use and where to use it. The Baldwin Locomotive Works, of which I am General Superintendent, have built over 500 four-cylinder compounds. We have built two two-cylinder compounds. When we first introduced this system of engine, the particular style of valves that we used was very much cried down, and it was said that it would prove a total failure and would interfere very much with what few chances the engine had of being a successful compound locomotive. It is this one point—the piston valve—upon which I cannot agree with Mr. Dean. We do not believe that there is any loss in using the piston valve due to the numerous apertures through which the steam has to pass, and the restrictions placed on the free passage of the steam by the bridges in the steam-chest, because by using the piston valve we are able to get a very much greater length of port with very little valve friction than we can with the ordinary slide valve. We are also able to operate steam pressures that it is utterly impossible to operate with the ordinary slide valve.

I cannot permit myself to speak of the numerous two-cylinder compound locomotives that have been changed over to single-expansion engines ; but in defence of the piston valve, I must necessarily speak of one, and that is on the Northeastern of England. Mr. T. W. Worsdell was one of the greatest advocates of two-cylinder compound locomotives, and he built a great number for that line—he has now been replaced by his brother. That railroad has found it necessary to change those engines to single-expansion engines. These very two-cylinder compound locomotives are now being fitted with single-expansion cylinders, and those single-expansion cylinders are being fitted with piston-valves, and indicator diagrams taken from those locomotives are far superior to any indicator diagrams I have seen taken from single-expansion locomotives with slide-valves. If the length of port is sufficient, if the passage is free so as to reduce the friction of the steam in passing from one cylinder to the other to a minimum, it seems to me it matters not whether you use a circular valve or a flat valve ; and if by the use of a circular valve you reduce your friction to a minimum, much less than what you have in a flat valve, then, it seems to me, it is desirable to use the piston-valve ; and in a great many cases the piston-valve can be used where it is utterly impossible to attach a slide-valve.

One reason why we went into this system of compounding was that we had inquired thoroughly into the two-cylinder system. The four-cylinder system is used on the Paris, Lyons & Mediterranean Road in France, and splendid engines those are, but very complicated. I was also in communication with Mr. Sigmund Cadena, now deceased, who was the Chief Superintendent of the Hungarian State Railway Engine Works in Buda-Pesth, and he assured me that he had failed utterly to adapt the two-cylinder compound to high speed passenger service, and had to resort to the four-cylinder compounds for the purpose, and found them very satisfactory. But for us to attempt to build an American engine, making it a four-cylinder compound with tandem cylinders, or inside cylinders with crank axles, or anything of that sort, would not have done at all ; we would not have been able to find a market for wares of that kind. The idea occurred to me that by placing the cylinders adjacent to each other—one immediately above the other—and connecting the two pistons to a common cross-head, supplying steam to both cylinders by a single piston-valve, we could get very good results. If we would have losses in some directions we would more than compensate for them by economies made in other directions. There would be no alteration to the locomotives, except to the cylinders outside of the frames and the guide and cross-heads. The internal arrangements, the smoke-box, the links and everything of that sort, would be exactly the same as on the single-expansion engines. Another valuable feature would be that it would be as well adapted to the very heavy decapod locomotive engines, weighing 200,000 lbs., equivalent to a 24-in. × 28-in. single-expansion engine, as it would be to an ordinary wharf rat used for street-car service. It would also do for heavy freight service, and answer for the very highest passenger service that we care to engage in in this country. It is this engine that has practically brought forth the very highest rates of passenger speed that we have had in this country. The Philadelphia & Reading Railroad are using the four-cylinder compound exclusively for their fast Blue Line trains between Philadelphia and Jersey City. The Central Railroad of New Jersey are using the four-cylinder compounds for the same work ; and fearing that perhaps the efficiency of these engines was due

somewhat to the design of the boiler and other details, and not to the compound cylinders, other engines of the same type exactly, excepting that the single-expansion engine was given the advantage of 2 in. larger boiler, were built and placed in the same service; but they had no business with them; the compound engines are hauling the trains, the single-expansion engines are doing other work.

I might go on and give you numerous illustrations of this kind. We have over 500 of these locomotives in service. We have made numerous tests. The economy ranges all the way from 10 per cent. up to 43 per cent. When you say 43 per cent., it seems like a very high economy; but it is due entirely to the anxiety on the part of the railway master mechanic to outdo the compound with his single-expansion engine. In this case that I speak of, where there was 43 per cent. economy, it was on a grade 12 miles long, 100 ft. to the mile, with very heavy curves. The engines were loaded to their utmost capacity; the compound locomotive, working full stroke, worked very economically, whereas the single-expansion engine worked at a very great disadvantage and not at all economically. I might add right here that in most of the two-cylinder compounds the ratio of expansion between the two cylinders is from 2 to 2.5, very seldom getting beyond that. I believe the Pennsylvania has one compound that is a little higher—probably about 2.65 or 2.70. We aim at a ratio of 2.8 to 3. We prefer 1 to 3—rather 1 to 2.7—2.85, 2.90, and up to 3 most all of our compound engines average, which gives us a very economical expansion of the steam. We also find the engines very well adapted to elevated railroad service. In Chicago, the South Side Rapid Transit Company, which runs a gilt-edge high-speed service, has 45 of these compound locomotives in service and one single-expansion engine. The single-expansion engine was first made a two cylinder compound in order to compete with the four-cylinder. As we are builders of locomotives, and there being no monetary return to me whatever for my system of compounds, we aim to get the very best, whether it is a four-cylinder or two cylinder compound, or three-cylinder compound or a single-expansion engine. We are in the locomotive business and not in the compound business. But the trials of these engines on the Chicago South Side caused the company to have the two-cylinder engine changed to a single-expansion, when it could not compete as a two-cylinder, and finally is used for switching service in the yard and not run in regular train service.

In coming over this evening from Philadelphia, I happened to ride behind a four-cylinder compound. We were a little late leaving Philadelphia. I timed the train mile after mile in 48 seconds to the mile with five vestibuled cars. It takes an extremely good engine to do that, especially with a small fire-box burning anthracite coal. We have made exhaustive tests of what is commonly known as the Wooten fire box fitted with compound-cylinders against the same engine fitted with single-expansion cylinders, and effected an economy of about 24 per cent. Another feature came out in these trials, and that was that the compound engine could burn a very much inferior grade of fuel, and the contrast was so great that now the Blue Line trains between New York and Philadelphia are using nothing but what is called buckwheat coal, which costs the company about 35 cents a ton, whereas before they used the best quality of egg coal for the work. The Philadelphia & Reading operates 78 compound locomotives.

The lowest water rate per I.H.P. that we have taken off has been at very slow speeds—say from 60 to 80 revolutions per minute in freight service on the New York, Lake Erie & Western Road, and those engines run as low as 17½ lbs. of water per I.H.P. per hour. That result was obtained, of course, by being able to get a very fine indicator diagram on account of speed. There was very little loss between the two cylinders, and the back pressure in the low-pressure cylinder was very slight. We have also noted in these trials that the most economical point of cut-off that we could find in a single-expansion engine was about one-quarter stroke, and that was about 27 lbs. of water per I.H.P. When we cut off at half stroke the water-rate had very much increased, due to condensation and less expansion, and at the three-quarter stroke it was very much more so. At shorter cut-offs the increase in water rates was very much more rapidly than when working beyond one-quarter stroke. In the compound engine we found a variation of about 2 lbs. in the water-rate between three-eighths and three-quarter cut-off; so that the indicator diagram has proved what we found in the tests, that the compound had a greater range of economy—that is, it could be worked at various points of cut-off and still be a very economical working engine; whereas the single-expansion engines could only be worked economically at one-quarter cut-off, and when you departed from that you would have made up your mind to waste coal in order to get increased efficiency out of your locomotive.

I have this to say: We have made numerous tests of these engines. We have the tests in printed form, and any one who takes a sufficient interest in the matter of compound engines, and would address me at Philadelphia, I would be very glad to mail him all the literature that we have on the subject, and he could read it at his leisure and digest it.

At this point, Professor Hutton read the following communication on

TWO-CYLINDER COMPOUND LOCOMOTIVES IN FREIGHT SERVICE.

BY C. H. QUEREAU.

Road Test with Dynamometer Car.—The following gives the principal results of careful road tests of two simple and two compound locomotives, made in freight service, with a dynamometer car, water metres, etc., in accordance with the code adopted by this society, except that the steam calorimetres used were found defective in construction and the results obtained from them were not used. For reasons which in no way affect the accuracy or reliability of the results, the names of the railroads owning the locomotives are not given. The averaged results of the tests will be found in Table I. The compounds were of the two-cylinder type, with a receiver in the smoke arch. A trip consisted of a run of 117 miles with 28 loaded freight cars, a different train being taken each trip. There were several 1 per cent. grades each way. The same engine crew handled all the engines, and the same testing crew of four persons took the records. All springs, gauges, and water metres were calibrated, coal from the same mine was used on all the engines, and great pains taken to have all conditions as nearly uniform as possible. Table A gives the principal engine dimensions.

TABLE I.

AVERAGED RESULTS.

Engine Number.	No. of Trips.	Dyn. H.P. Hrs. per Trip.	Water per Dyn. H. P. Hour.		Speed, Miles per Hour.	Steam Pressure.
			Lbs.	Per cent.		
1 Compound..	5	2,105	33 7	102.4	20.6	171
2 "	6	1,906	32.9	100.0	23.2	170
3 Simple ...	4	1,918	38 6	117.3	19.4	171
4 "	5	1,922	38.5	117.3	18.4	179

TABLE A.

ENGINE DIMENSIONS.

Engine...	Number 1.	Number 2.	Number 3.	Number 4.
Type...............	2-Cyl. Comp 10-wheeler.	2-Cyl. Comp Mogul.	Simple. Mogul.	Simple. Consol.
Mean running weight, lbs.......	200,000	172,000	182,000	175,350
Weight on drivers..	118,000	98,000	106,500	101,800
Diameter of drivers over all	56"	62"	62"	49"
Cylinders, in.......	19 & 30 × 24	20 & 29 × 24	19 × 24	20 × 24
Valve travel........	5½"	6"	5"	5½"
Valve..............	Plain bal.	Plain bal.	Allan bal.	Plain bal.
Exhaust nozzle, diameter...... ..	5"	4⅞"	5"	5"
Diameter of boiler..	58"	56	60"	60"
Grate area, sq. ft...	31.3	31.5	31.5	34.7
Heating surface, sq. ft........	....	....	....	....
Tubes........... .	1,756	1,380	1,555	1,391
Fire-box...........	172	126	136	164
Total....	1,928	1,506	1 691	1,555
Miles on flues	8,000*	7,318	5,941	42,231
Miles on fire-box...	8,000*	133,322	56,526	150,353
Pops released at....	185 lbs.	185 lbs.	185 lbs.	185 lbs.

Because of the great differences in the distribution of the heating surfaces, and differences in their condition due to scale accumulated during varying periods of service, as shown in Table A, the evaporative efficiencies of the boilers and the coal used by the different engines are not comparable, and are not shown in Table I. It, however, shows that the conditions as to work done, speed, and steam pressures, were reasonably uniform for the several engines; that the compounds were more economical than the simple engines in the use of steam by 15 per cent.; that this saving was not due to the use of higher pressures for the compounds, and should therefore be attributed to the compound principle.

The figures given in Table I. for water used per unit of power developed are based on the assumption that all the water was used in hauling the cars. In Table II. is given the water used per unit of power developed in hauling the total load, which includes the engine as well as cars, based on the weights of the engines and cars. As the weights of the cars and their contents were taken from the stenciled weights on the cars and the bills of lading, Table II. should be considered as only a close approximation.

* Estimated.

TABLE II.

Engine Number.	Water per Dynamometer H.P. Hour.	
	Lbs.	Per cent.
1 Compound	30.0	101.4
2 "	29.6	100.0
3 Simple	34.7	117.2
4 "	35.2	118 2

From the dynamometer records the average pull for each engine for all its trips was found, and indicator cards from each engine were selected which showed on the dynamometer record practically the same pull as the average. The average indicated water per I.H.P. hour was then calculated for each engine from these cards. The results are given in Table III.

TABLE III.

Engine Number.	Average Pull of Engine.	Pull for Card.	Indicated Water.	
1 Compound	8,340	8,600	16.92	17.20
2 "	7,520	7,500	17.50	
3 Simple	7,350	7,500	18.80	18.90
4 "	7,000	6,900	19.00	

Inasmuch as the indicated water is a fair basis on which to compare the efficiency of engines in expanding the steam used, it follows from Table III. that the steam was expanded by the compounds 9 per cent. more economically than by the simple engines. Table 2 shows that the compounds used steam 15 per cent. more economically than the simple engines. It would seem just to believe that the difference between 9 per cent., the saving of the compounds due to better expansion, and 15 per cent., the total steam economy of the compounds, was due to a saving because of less cylinder condensation. That the effect of the receiver in the smoke arch was beneficial in reducing condensation there can be little doubt, but tests of compound engine 2 have shown that there was no superheating of the steam as it passed through the receiver. It seems reasonable to assume that, had the boilers of the compound and simple engines been the same, the economy of the compounds in coal would have been at least as great as their economy in the use of steam.

Records Made in Service.—In Table IV. are given results obtained from records made by compound and simple locomotives in regular freight service obtained from the roads owning the engines. In each case the compound and simple engines compared were identical except in modifications of cylinders and valve-gear made necessary by compounding; they were also operated on the same divisions and in the same service. The Chicago, Burlington & Quincy engines were run in the same pool, each engine crew taking each engine in turn.

TABLE IV.

Railroad	C., C., C. & St. L		C., B. & Q.		C. & O.	
Period covered by records	9 months		1 month		1 year.	
	Comp.	Simple.	Comp.	Simple.	Comp.	Simple.
Engines in service	1	12	1	40	1	10
Steam pressure, lbs.	180	180	180	160–180	155	150
Aver. train, loaded cars.	24.7	24.3	31.6	25.1	35 1	36.1
Lbs. coal per car mile	3.7	4.8	3.27	4.6	3.7	4.9
Best simple coal record.		4.2		3.85		4.4
Repairs per 100 miles	$3.90	$4.09	*		$1.61	$2.27

As in Table 1, the simple and compound engines used practically the same boiler pressure, and the difference in economy is due to the compound principle. Table IV. shows a saving in fuel for the compounds as follows:

	C., C., C. & St. L.	C., B. & Q.	C. & O.
Over average of all simple engines.	23%	29%	25%
Over best simple engine record	12%	15%	16%

The Cleveland, Cincinnati, Chicago & St. Louis compound has been in service about two years; the Chicago, Burlington & Quincy compound about four years; and the Chesapeake & Ohio compound about two and one-half years.

Table IV. further shows that the compounds hauled as heavy trains as the simple engines.

Conclusions.—The writer would draw the following conclusions:

1. There are compounds in service which are more economical in the use of coal and water than simple engines of the same dimensions and doing the same work in freight service.

2. The minimum economy of the compounds is not far from 15 per cent. It is probable that about two-thirds of this economy is due to a better expansion of the steam, and about one-third to less loss by condensation.

3. The compounds have been in service too short a time to warrant final conclusions as to their cost for repairs, but the experience to date and theoretical considerations strongly indicate that this item will be no larger for the compounds than for the simple locomotives of the same dimensions and doing the same work.

Mr. Ball: Mr. Vauclain has told us about the advantage in the piston-valve in the way of large port openings and saving in the friction in the valve; but I do not remember that he said anything in regard to the question of possible leakage. I do not know whether they have had any trouble of this kind in the locomotive or not.

Mr. Vauclain: In casting the cylinder it would not be a wise thing to cast the bridges and everything in the ports in the cylinder casting. We therefore allow the ports to terminate in this cylinder, and fit a cast-iron bushing in, carrying the ports, and bridge them over. We do that on account of the valves. The valve is fitted with packing rings just the same as an ordinary piston, and these packing rings take the wear. We were afraid that we would have trouble with these valves; but having had several years' experience with Westinghouse stationary engines, both compound and single expansion, we were brave enough to start out and put piston-valves in locomotives. We have never had a bit of bother with steam engines running with packings of that type. The rings are ordinary cast-iron rings sprung into position, so that when they feel the push they come together within one-sixty-fourth of an inch. The bottom of the casting has a wide bridge on which the ring abuts in the centre, so that as the ring wears it gradually moves around a trifle. We were afraid that these bridges would wear the rings in grooves, and the rings did wear in grooves in some cases. We found that where they did so wear it was on engines that were used in drifting down heavy grades and not permitted to run at full stroke or run partially in the cut-off, the reversing lever pushed out slightly, which caused them to suck in dirt and cut out the rings of the low-pressure valve. By putting larger relief valves on this engine and keeping the sparks from being drawn into the valve chest we entirely did away with that cutting.

A few days ago I was on the Norfolk & Western Railroad, and asked Mr. Soule how soon he thought that he would have to renew some of his bushings. He has some large engines there that we built three years ago, and since that time we have concluded to enlarge the valves 1 in. on that size of engine. I advised him to rebore the cylinder and put in a larger bush. He remarked that he would when these bushings gave him trouble; that he was very much disappointed; that he had looked for a great deal of trouble with these piston-valves, and that they had given him less trouble than the slide-valves.

The President: You spoke of being able to use higher boiler pressure with the piston-valves than without. What is the highest pressure you have used?

Mr. Vauclain: Two hundred and twenty pounds is the highest pressure we have used. This point was brought out on the Chicago, Milwaukee & St. Paul Road in this country, and in England it was found that at 170 lbs. they had reached the limit for slide-valve service; but after they got beyond 175 lbs. they had trouble with the valve getting dry and cutting. On the Chicago, Milwaukee & St. Paul we built them some engines 180 lbs. pressure single expansion, and also one compound; the compound showed an average fuel economy for the entire year of about 17 per cent. running against those engines. Mr. Barr, who is very glad to find out if there is any economy in an engine, whether it is compound or single expansion, thought that perhaps by running his single-expansion engines at 200 lbs. pressure he would get just as good results as with the compound. The compound was running at 200 lbs. They increased the pressure on the compound from 180 lbs. to 200 lbs. on account of the diameter of the cylinders being slightly under what the cylinder power was on the single-expansion engine, and as the boiler had been built for 200 lbs. on both classes, they screwed down the safety-valves and let the single expansion run at 180 lbs. and the compound at 200 lbs. When the single expansion was put up to 200 lbs., they found no end of trouble; their valves got dry, and after several months' experimenting, I think that Mr. Barr succeeded in balancing the valve, or getting it so that it gave him very good satisfaction—at least he thought so; but other things came into play. He found that there was a loss of economy by increasing the single-expansion engine to 200 lbs., and they put it back to 180 lbs.

* Because of several changes in valve gear, and a wreck, charged to repairs, it would be very difficult to determine the cost of repairs for the C., B. & Q. compound. It is the opinion of those having the engine in charge that her repairs cost no more than for the simple engines, if as much.

We have run 235 miles with a pint of cylinder oil, in high-speed passenger service, burning the very worst kind of fuel, which is bituminous coke. The grit and dirt from coke, if drawn into the cylinders, cut them like emery. We built an engine for the World's Fair, called the *Columbia*, with 7-ft. driving-wheels, of decidedly new type for this country. The Philadelphia & Reading are the only road using them. They have a two-wheel pony truck in front. The driving-wheels are in the centre of the engine, and a trailing-wheel back. This engine ran from Washington to Jersey City on one tender load of coal and one pint of lubricating oil, and there was still some lubricating oil left in the lubricator when we got there.

The President: I think, Mr. Vauclain, if you will excuse me for saying so, that your comparison of the 200 lbs. pressure of the simple engine compared with the compound is liable to be misleading, because in the compound engine you have the pressure divided half and half between the two cylinders, while the low-pressure cylinder would not have more than the receiver pressure on the back of its valve on the other side; and although there is 220 lbs. on the top of the valve, there would be about half of that under the valve in the receiver, so that the difference would be considerably less than in an ordinary simple engine. So I rather fail to see why a compound engine could not carry 220 lbs. with a slide-valve as well as the simple engine could carry 150 or 160 lbs.

I think it no more than right to explain that, although I am in the chair, I may have had experience in the matter that may be of benefit to the fraternity at large that might not come in in any other way. I happen to know of, and have been interested personally in, the testing of a compound engine recently which carried 220 lbs. of steam with the ordinary slide-valves balanced in the usual way. Part of the time they had the American balance and part of the time the Richardson balance. The ports were 23 in. long; and that engine carried for one month, under very severe service, 220 lbs. boiler pressure, and for the remainder of the time, 200 lbs. But I made a particular point of examining the valves to see if the faces stood the wear well—and they did. There was no appreciable cutting of the faces at all, and it was concluded that that pressure was not excessive for that type of valve in that case. I only mention that as a piece of information that ought to go side by side with the statements of Mr. Barr's experience with the other engine.

Mr. Durfee: I would like to make some inquiry as to whether any of the bars dividing the ports on compound or other engines using piston-valves have been made inclined to the axes of the cylinders. Some years ago, on the Edinburgh & Glasgow Railway, there were some very large engines built with piston-valves, and the ports of those engines were that way—the bars dividing the ports were placed at an angle, so that they did not have any effect of grooving the piston-valves. I do not know that that construction is in use at all at the present time.

Mr. Vauclain: We have made probably a hundred bushings of that sort; and we think that it is simply a matter of choice. The angular bridge may wear the ring much better than the straight bridge. But the straight bridge gives sufficient satisfaction, and is very much more easily made, and you are less liable to break the bushing forcing it in with a straight bridge than with an angular bridge. It is for that reason that we adhere to the straight bridge. But for any one desiring such a bridge, we are happy to put in the angular bridge and bushing.

Mr. Dean: I have had something over three and one-half years' experience now with the compound locomotive carrying no less than 180 lbs. of steam, and a good deal of the time carrying 195 lbs. While the engine had been in service three and one-half years, the slide-valves had never been taken out of the chests, and there was no reason for doing it. Recently, however, Mr. Henney, who succeeded Mr. Lauder on the Old Colony system, desiring to ascertain independently the relative merits of the compound engine and the simple one, has had the compound engine taken into the shop, and also the simple engine, and both engines are being put into the very best possible condition. Whether it was known that anything was wrong or not, no chances were taken; so that the valves were taken out of the chests with the idea of facing off the valve seats and valves of the compound engine. When they were taken out after three years of service, the foreman of the shop was quite undecided whether it was best to face off those valve seats or not. But I finally told him that we had better have everything as good as we could have it, because this was a very important test—it was to convince a sceptic. The valves and the valve seats were simply admirable after this long term of service. Not only is this the fact, but in running the engine the engineer can take hold of the lever with his left hand and move it when steam is on just as easily as not. There is very substantial evidence that a slide-valve with the Richardson balance is perfectly satisfactory in pressures above 180 lbs.

Mr. Bishop: The greatest trouble we have had with the Webb compound is being unable to start the low-pressure cylinder of the front pair of wheels. The valve motion was run with the link motion and two eccentrics, and that was afterward changed to a loose eccentric, with a step for forward and back motion; so of course the engine would have to be started before the eccentric would come to a start governing either motion. So in backing up to the train the eccentric was set for the back motion, and unless you started the train the back wheels would go forward and the forward pair of wheels would go backward, and of course it was impossible to make any progress; and if the low-pressure wheels happened to get on the centre, the receiver would fill up and no progress would be made in any direction, so that it was found to be almost impossible to use it on any of our trains, and it has been out of service most of the while. I think that the valve motion on that engine was in very bad shape. I saw some indicator cards from the engine which showed excessive back pressure in the high-pressure cylinders, and that the valves were not square; so that perhaps that would account for not being able to get a speed of much over 60 miles per hour out of the engine; the engine was very rough riding and had a very jerky motion.

Mr. Forney: I have listened to the discussion this evening with a great deal of interest; but it has been all one-sided, and I think there are some things that might be said with reference to the question that have not been said. Of course, for any one to come to a meeting of mechanical engineers with the statement that you cannot save fuel with a compound locomotive would be to talk nonsense. But there is a decided difference between saving fuel and in saving money in locomotive service. I have no doubt, either, that in certain kinds of service the economics which have been reported here this evening can be gained with the compound locomotive; but that is a very different question from the economics which can be gained in the average service which must be performed on railroads. I remember, not a great while ago, seeing the report of the performance of a compound locomotive, setting forth the advantages which were gained and the saving in the fuel. On investigation it was found that that locomotive was used on a heavy mountain grade where there was a continuous hard pull, and on which it would have been necessary to work a simple engine at full stroke all the way up to get the best results. Of course under such circumstances the compound showed an enormous saving of fuel. But the railroads of the country generally are not composed of continuous up-hill grades, so that if that engine had been running over the whole length of the line of road on which this test had been made, the saving would have been very different from that which was shown. I also saw a report of one or two compound locomotives in which there is a comparison made of the average performance of 10 engines on two different roads. Now, on making a comparison with the simple engines it was found that the difference between the performance of the best simple engine and the worst simple engine in those 10 was considerably greater than the difference in the performance of the compound and the average of the simple engines. In other words, it makes a very great difference whether you compare a good compound engine with the performance of a poor simple engine. I think in a great many of the tests which have been made thus far with compound engines, they have had counsel for its side. They have had friends who were interested in producing the very best results for the compound engine in the test. But the simple engine has gone into the test without such friends. Some time ago a test was made by Mr. Webb, of the London & Northwestern Railroad, with one of his compounds of the *Greater Britain* type. The report of the performance of that engine, the figures of which I have not with me and do not remember, were the most remarkable that had ever been shown up to that time. About a year ago Mr. Buchanan, of the Hudson River Railroad, made a test of one of his engines of the celebrated No. 999 class, and in that test he produced somewhat better results than Mr. Webb produced with his compound. In that case Mr. Buchanan was interested in producing the very best results with his simple engine, whereas, if Mr. Webb's engine had been tested with some other simple engine and under circumstances where no one was interested in producing the best results, the case might have been very different. At the last meeting of the Master Mechanics' Association, during the discussion of the relative merits of simple and compound engines, a member got up on the floor and stated that it was a most remarkable thing that you could get no one to come on the floor of the Association and say anything which seemed to be derogatory to the com-

pound engine; but if you went out on the veranda of the hotel and sat down in private conversation with the members, he found a great many bitter enemies of the compound system. If you will go around the country you will find there is an immense difference of opinion among people best able to form an opinion with reference to the question of the relative economy of the two classes of engine. I was in correspondence a short time ago with a gentleman who has abundant opportunity of getting information, who is on the continent of Europe, and he wrote me that exactly the same condition of things existed there; that the locomotive superintendents of European railroads were very much divided, and that it was difficult to say on which side the preponderance of sentiment lay. The fact which was related here this evening, that on the London & Northeastern they were changing some of the compound engines into simple engines, is also significant. My mind is still undecided in reference to this question. I think the probabilities are that for certain kinds of service the compound engine will be found ultimately to be the most economical engine, but for much of the service of railroads I think it is still questionable. There was a good deal said this evening by Mr. Nichols with reference to the economy of compound locomotives on elevated railroads. Now, if all the advantages stated here this evening are true, if there are no drawbacks to those advantages, it seems to me that the managers of the elevated railroads of New York must be a blooming set of idiots (*laughter*) not to adopt compound engines as early as possible. It was also said here this evening by the same gentleman that compound engines must be kept in a better state of repair than simple engines; they must be run more carefully than simple engines. Another gentleman said that in order to pull the maximum train on a heavy grade it was necessary to work compound engines simple. Those are very important facts. If you are obliged to keep a compound engine in better repair than a simple engine, that militates against the compound system. If you are obliged to have a superior class of men to run the compound engines, and if your compound engines will not pull your train at the point of maximum grade in going up a hill, those are serious questions. There is also this fact: Compound engines certainly do cost more than simple engines. It is not an easy matter to ascertain precisely what that difference of cost is. It is also another fact that a compound engine weighs considerably more than a simple engine. Now, if I were called upon to design a simple engine to run in competition with a compound, I should be very careful to take that excess of weight which now goes into the cylinders and steam-pipes and valves and various fittings and put it into the boiler, so as to have it larger, and in that way increase the economy in the boiler itself. Now, the fact that the compound system implies more weight is to that extent a disadvantage of the compound system, and I think that if these things are taken into consideration we would be obliged to hold our opinion somewhat in suspense for the present before we come to any sweeping conclusions. As I said before, I believe that for certain kinds of service the compound locomotives would be found to be the most economical and the most efficient; but I believe that thus far we ought to bring in a Scotch verdict of "it has not been proven."

The President: In what I have to say I am entirely disinterested. I am not connected in any way at present, nor likely to be, with any concern building compound engines or locomotives. What I will state will be simply from my experience as an engineer at a time when I did have to do with compound engines. Mr. Forney's criticism as to the increased weight of the compound engine refers simply to the difference of weight in cylinders which puts a little more weight on the front truck. But the difference of weight he finds is really in the boiler. The compound engine can utilize a boiler of higher power to more advantage than the simple engine, for which reason it is perfectly fair to give the compound engines the higher boiler power. That puts more weight on the wheels. In the compound engine of what I think I may be excused for saying is the latest type, there is always reserved the possibility of throwing that engine into a simple engine whenever the service requires it—that is, to turn the engine into a simple engine and get about 25 per cent. more power to cover emergencies. In that way the weight of the train can be increased when there is a number of points where the grade is so heavy that it would limit the average train, and the engine would be pulling under its proper load. That limits a simple engine; and it is perfectly legitimate that the compound engine should take advantage of its capabilities of being able to overcome that by a sudden burst of power. While that, of course, would use a little more steam than the compound engine would use for the time being, it enables the engine to carry a higher average amount of tonnage, and the slight waste of steam is more than overcome by the increased tonnage for the rest of the trip. That is one of the advantages that legitimately belong to the compound engine of the type that has taken advantage of all the possibilities that lie within the limit of the compound system. In regard to the prejudice in favor of the compound engine, I think if Mr. Forney had ridden on as many engines as some of us have who have been trying to introduce compound engines, he would find that the prejudice is exactly the other way—that the compound engine has no friends except the man in charge from the works, whereas the simple engine has friends on every one of the railroads. Whatever advantage the compound engine shows is in spite of the greatest amount of opposition that an engine could possibly have. But the object of these meetings ought to be to bring out both sides of such questions, and I believe it can be truthfully said that this has been the case to-night. There has been no effort on anybody's part to make out the compound engine to be any better than it really is. The tests given have given both sides. The conditions have been as nearly similar as they could possibly be made in testing the two types, and I think it is a remarkable fact that any one could state at this day that prejudice is in favor of the compound engine, because the compound engine is a new thing, and, as Mr. Nichols said, is being introduced against the conservative ideas of the powers that be. So that when a compound engine comes on a road it has to labor against all the disadvantages that Mr. Forney seems to think the simple engine has. In spite of that, we find that the compound engine to-day is gaining ground instead of losing it. Of course the original types of compound engines were very faulty. I think you will find that every improvement in machinery has been gradual, and mistakes have been made; but if you will take some of the later engines, where people have availed themselves of the experience of those who have gone before, you will find that those engines have been unqualified successes in every instance. I could name engines of certain classes that have been invariably successful, and in whose favor at the meeting of the Master Mechanics' Association last year the verdict was universal.

Mr. Yerrets: Can Mr. Vauclain give me any figure as to the cost of repairs of any one or of all of these engines that are on the Philadelphia & Reading Road, drawing its fast Blue Line trains? I think that would be an additional point on which we might very readily gain information.

Mr. Vauclain: I believe that the repairs to the compound engines of the Philadelphia & Reading Railroad are about 75 per cent. to 80 per cent. of what the repairs cost on the single-expansion engines. On the passenger engines there is very much better than that, probably not over 60 per cent. of what the single engines cost them for repairs in hauling the same service. That is not due entirely to the compound engines. The compounds have a slight advantage over the single-expansion engines by having a little larger wheel, and we look in compound engines for the same repairs—about the same repairs as we have in single-expansion engines. We look for a saving in boiler repairs—very much so. In cylinder repairs we look for an increased amount of repairs, due to having four pistons to take care of in place of two. Mr. Soule, of the Norfolk & Western, kept a record of this, I believe, and found that the total cylinder repairs to an engine did not exceed 5 per cent. of the total repairs; and as I told him that I would concede him twice the cylinder repairs to the compound as he had to the single expansion—it would not make any great figure in the comparison of repairs—whereas the boiler repairs were less in a very much greater proportion. We think that the compound locomotives would require about the same repairs as the ordinary single-expansion engines; under certain conditions it would be less, and very exceptionally greater—due to some carelessness, perhaps, if it were greater. I might say in this connection that I have had to father the four-cylinder compound as built by the Baldwin Locomotive Works, being the patentee of it. I have been in all sorts of service with it. I have had to meet the most earnest competition on the part of railroad companies with single-expansion engines. I heartily endorse everything Mr. Davis has said. The very highest economies that we have had with compound engines have been obtained really competing with single-expansion engines that were specially groomed and superintended and looked after by the railroads in order to knock out the compound locomotive. Where the engines were taken and properly treated, and as much care bestowed on one as the other, we have had about the minimum. The minimum economy we have effected has been on the Chicago, Milwaukee & St. Paul Road; and I think if we ever had fair treatment on a railroad we had it on that one, and that engine ran against simple engines carrying 180 lbs. of steam pressure instead of 160 lbs. We have found very high economies in running against 140 lbs. in place of 180 lbs. I acknowledge the fact that I have had a great

deal of grief in connection with compound engines; it is a baby, and at this present time we have not been building compounds for 60 years as we have single-expansion engines. We do not know all the tricks in order to get additional advantages; but we are rapidly learning them, and while I have had a great deal of grief over a great number of sick children, I have never had yet had to mourn over a corpse.

THE CURVE OF LEAST RESISTANCE IN WATER AND IN AIR.

By Meety Moulton, S.B., Newport News, Va.

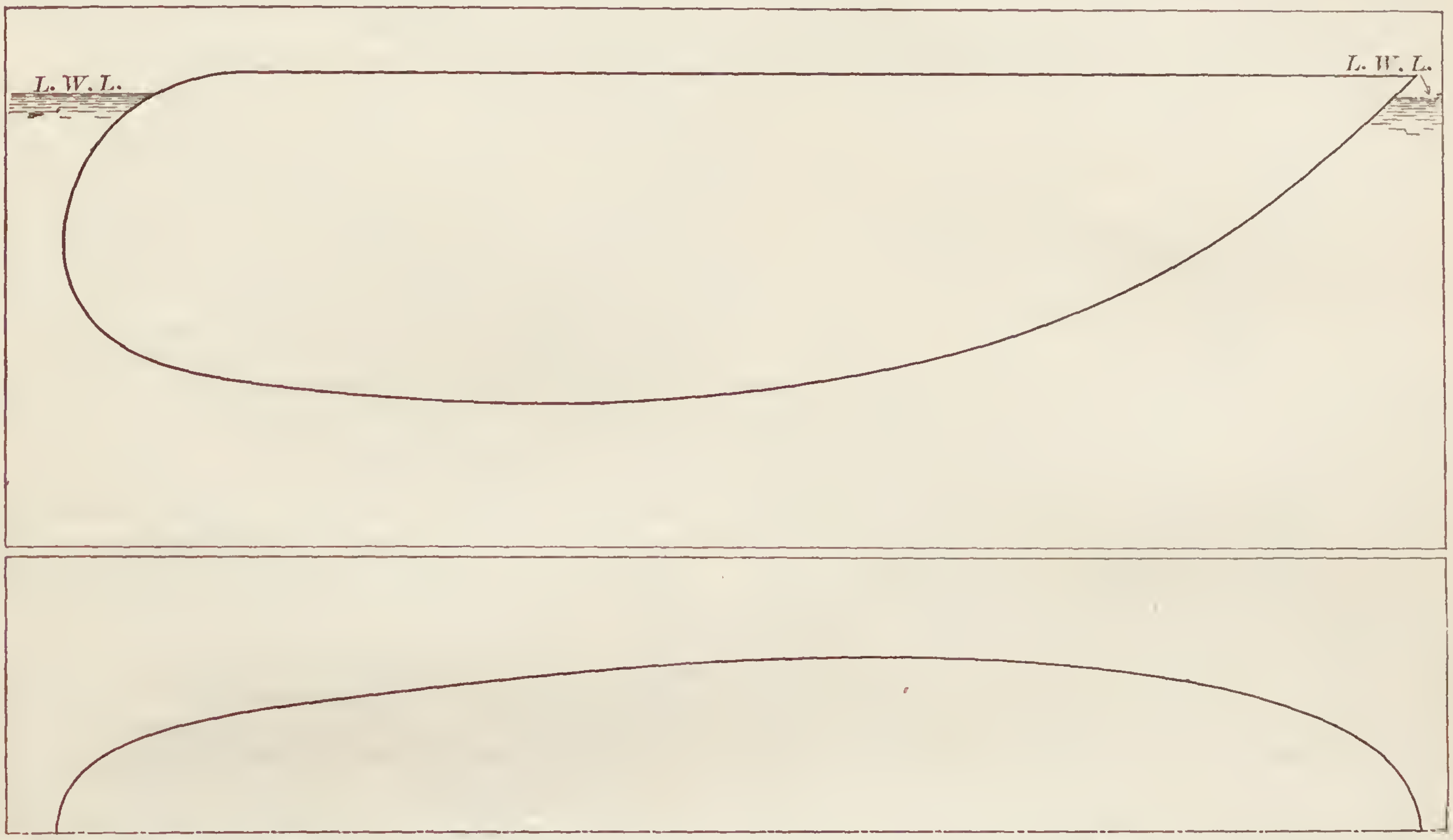
The following report of a series of very ingenious experiments, to determine the forms of least resistance in air and water, have been made at Newport News recently. We hope in the near future to give fuller particulars of the results of these investigations.

The idea of the experiments to find the curve of least resistance in water and in air was to use the friction of the medium itself (water or air) to shape the model. In water, blocks of ice of various sections and lengths were used. In air, wax cylinders of various lengths and sections were held in currents of hot air.

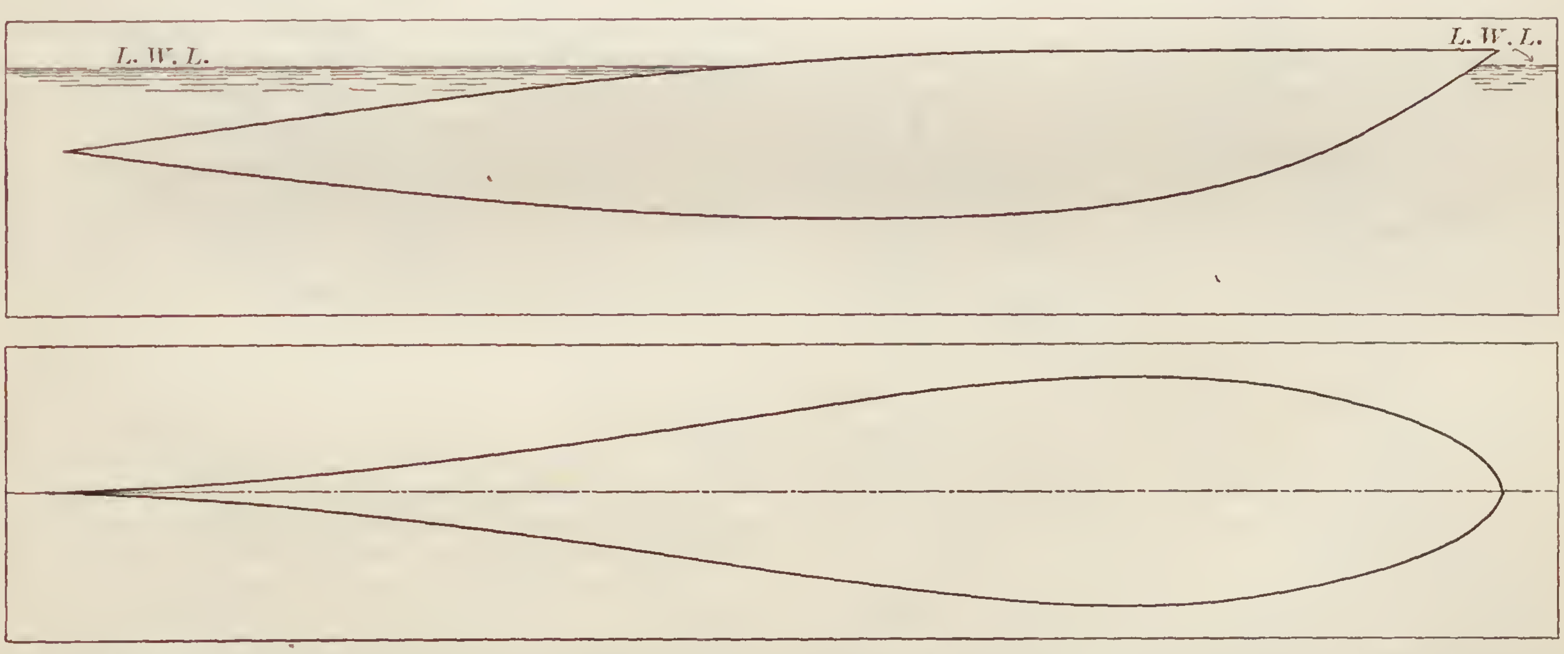
The first experiment with ice in water was performed on March 10, 1895. It will give a good idea of all the others.

The block of ice was just 9 in. square by 2 ft. long, and weighed 90 lbs. In order to tow it, a wire encircled the ice lengthwise (a deep saw-cut holding it in place). This idea was unfortunate, as the ice melted faster at the wire. In all the succeeding experiments, however, a small wooden rod was frozen in at the proper place, and the towing-wire fastened at the end. The first result after towing the ice 20 minutes, until it had shaped itself according to the wave it displaced, was very interesting and satisfactory, notwithstanding the roughness of the model formed. The under part or keel sweeps in one gradual curve from the bow almost to the stern. The stern in itself is unique, curving up rather suddenly and bending forward.

From the sides very little seems to have been taken away, which proves unquestionably that the displacement waves are caused almost entirely by the bottom.



MODEL A. RECTANGULAR OUTLINE INDICATES ORIGINAL BLOCK OF ICE, HEAVY LINES THE REMAINING MODEL. SCALE, ¼ SIZE.



MODEL B. RECTANGULAR OUTLINE INDICATES ORIGINAL BLOCK OF ICE, HEAVY LINES THE REMAINING MODEL. SCALE, ⅛ SIZE.

Curious features are the almost straight sides and the square section of the remaining ice. The forward end of the deck is neatly rounded, and deck and keel meet forward in a point. The after end is also rounded, but is flooded by the curling back of the returning waters. When the ice was taken out it weighed 14 lbs. The temperature of the water remained constant at 40° F., and of the air at 41° to 42° F.

The pull on the ice was carefully measured, and gradually

decreased from 6 lbs. to 1 lb. The largest section was reduced by one half at the finish.

The model was then taken from the water and pressed into a box of prepared plaster of Paris, and the mould thus formed. Two hours later the ice could be removed, and a perfect mould remained. A cast was taken; this was templeted and the lines were carefully drawn.

All the experiments give very nearly the same lines, more or less smooth according to the section of the block. Blocks of all sections were used, beginning with square blocks 2 to 4 ft. long (4 ft. preferred) by 9 in. square; then blocks of circular, semicircular, triangular, and other sections were used, as well as blocks immersed by freezing into the ice enough to make it sink.

The only objection to the use of ice is the roughness of the model formed from it; the air-bubbles in the ice cause it to become honeycombed as it melts.

With air the results are practically the same. Cylinders of wax of various cross-sections were suspended in a specially tapered pipe and a current of hot air allowed to flow around them. The wax cylinder takes the shape the air gives. The temperature, speed, etc., of the air is carefully noted. The cylinder is then allowed to cool and is then carefully calipered to the thousandth of an inch.

In both cases (in air and in water) all the curves run smoothly from end to end.

WATER-JET PILE-DRIVING.

By James F. Hobart.

Having occasion to drive a large number of piles on a sandy sea-shore with blue clay beneath 12 to 15 ft. of sand, resource was had to the water-jet for the purpose of sinking the piles through the sand, after which they were driven at least 8 ft. into the clay. Water was supplied by a duplex Worthington pump, an ordinary boiler being erected with the pump at the water's edge, and the liquid forced through about 1,000 ft. of 5-in. piping to where the pile-driver was located. A foot-valve was put into the suction-pipe, which necessarily was about 60 ft. long. The foot-valve was built up of two flanges, a large section of pipe, a piece of leather, and a bit of rubber gasket.

Fig. 1 will give some idea of the appearance of the foot-valve, the flanges *a* and *b* being screwed to the pipes, and the large piece of pipe *c* being turned up in a lathe until the ends were true. The flanges were likewise faced off in a lathe. The clapper to this valve was formed of a piece of leather cut down, as shown in fig. 2, a piece of iron, being attached by a bolt to the clapper of the valve. Another but thinner piece of iron was placed underneath the clapper, as shown at *e*. This prevented the leather valve from collapsing under the pressure of the water.

The large piece of pipe forming the body of the valve shown in fig. 3 is, as will be seen, merely a plain piece of steam-pipe about 8 in. in diameter faced up as described above. A plain rubber gasket, fig. 4, is cut out and placed between the flange *b* and the shell *c*, fig. 1. The leather which forms the gasket and the valve is placed between *a* and *c*. This contrivance, when well and evenly screwed up, forms a perfectly tight valve, which works in good shape, and as yet has given no trouble whatever.

The water-jets were formed as shown in fig. 5, the 5-in. pipe having a T screwed upon the end thereof, and being fitted with elbows and reducing nipples, bringing its diameter down to 3 in. Strong rubber hose 3 in. in diameter were attached to the nipples, and to the end of the 50-ft. lengths of hose the water-jets were attached, consisting of lengths of plain 1½-in. pipes. The method of connecting is shown at *a*, in fig. 5. The hose being attached to a nipple, this screwed into an elbow, another nipple 6 in. long is inserted, then another elbow, and the jet-pipe is screwed into the second elbow.

The rope tackle by which the water-jet was managed is attached to the long nipple *b*, as shown. Two of these jets are used, the pipes *c* being about 15 ft. long. The piling is driven as shown by fig. 6, the two central piles being vertical, while the outside of spur piles have a batter of 3 in. per foot. It proved quite a problem to drive all four of these piles with the same machine. The spur piles could evidently be driven easily enough if a special machine were built for the same rake or pitch—namely, 3 in. per foot. But as two out of four piles had to be driven vertically, the special machine would not answer, and the low price at which the contract was taken forbade the use of two machines.

The piles were finally driven by arranging the machine as shown in fig. 7. The vertical pile having been driven as shown, the spur was erected after the machine had been racked over as far as possible, the spur pile being shown in position on top of the ground at *b*. It was placed diagonally under the hammer, as much as the width of the pile-driver would permit, as seen in the engraving. While in this position the water-jets were applied at *c*, so as to loosen up the sand at the right of the pile, causing it to work in that direction to a considerable extent, thus increasing the pitch of batter.

The foot of the pile was sharpened, as shown in fig. 8, all the cutting being done on one side of the pile, giving a one-sided bevel as shown. When this pile was driven it possessed a natural tendency to work off in a right-hand direction. This tendency was increased as much as possible by the use of the water-jets on that side, as described in fig. 7. As the driving proceeded, it was found that the pile cramped in the machine at *b* and *d*, causing the frame to be badly sprung out of shape. Driving was persevered in, and as the pile got down below the machine, as shown in fig. 9, it was necessary to move the machine to one side in order to bring the pile central, as shown by fig. 10. In this manner the spur piles were driven down to the required depth.

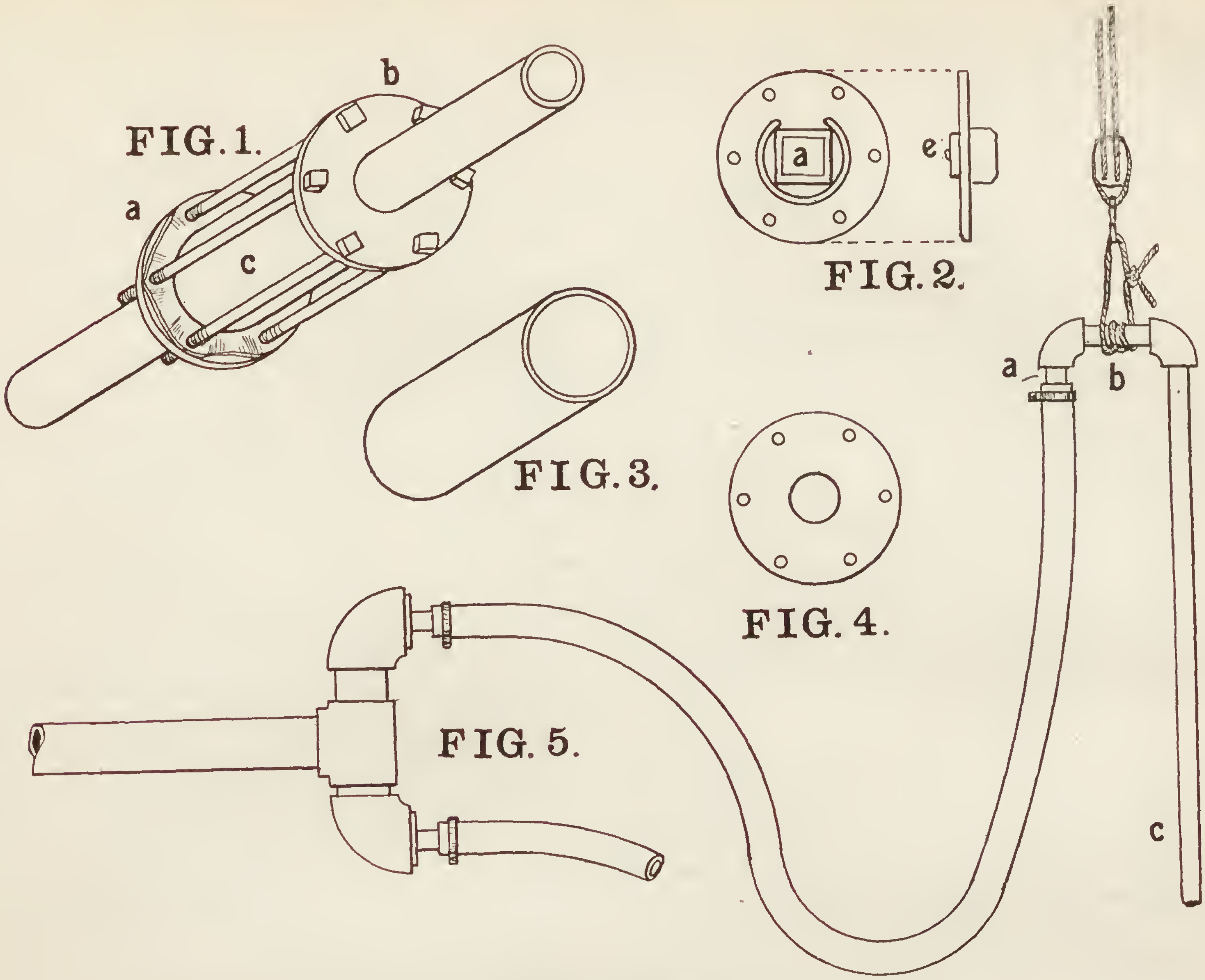
In order to ascertain whether or not the required batter was obtained, I caused a workman to dig down about 3 ft. beside one of the bents, and straight edges were set up beside each pile as nearly in line with the centre as possible. Measurement showed that the batter of the pile was 2⅞ in. per foot, very close to the 3 in. required. The cramping of the pile in the machine, as above described, soon resulted in damaging the driver to such an extent that repairs were necessary. To this end a piece of 4-in. hard pine plank was bolted to the pile-driver frame. This proved a useless expedient, as the very next pile that was driven the bolts were torn out of the hard pine strengthening piece, which was not only split in several places, but cracked almost across at one or two other spots, making it necessary to replace the repairs with white oak strips 8 in. wide and 6 in. thick.

It would, as stated, have been much better to have removed the defective stand of the machine and replaced it with oak, but it seems to be the policy of some contractors to think that "anything is good enough for the man on the job," hence the necessity of making the "chip and string" repairs mentioned above. In driving these piles with the water-jet it was found most effective to place the pile in position, each pile being 25 ft. long, 12 in. in diameter at top, 6 in. at smaller end. When in position the hammer was allowed to fall lightly upon the pile, then the water-jets were applied, one upon each side, the jets were run down about 4 ft., then withdrawn and run down again at 90° from the first position. After remaining for a minute in this position, one jet was forced about 2 ft. further in the ground.

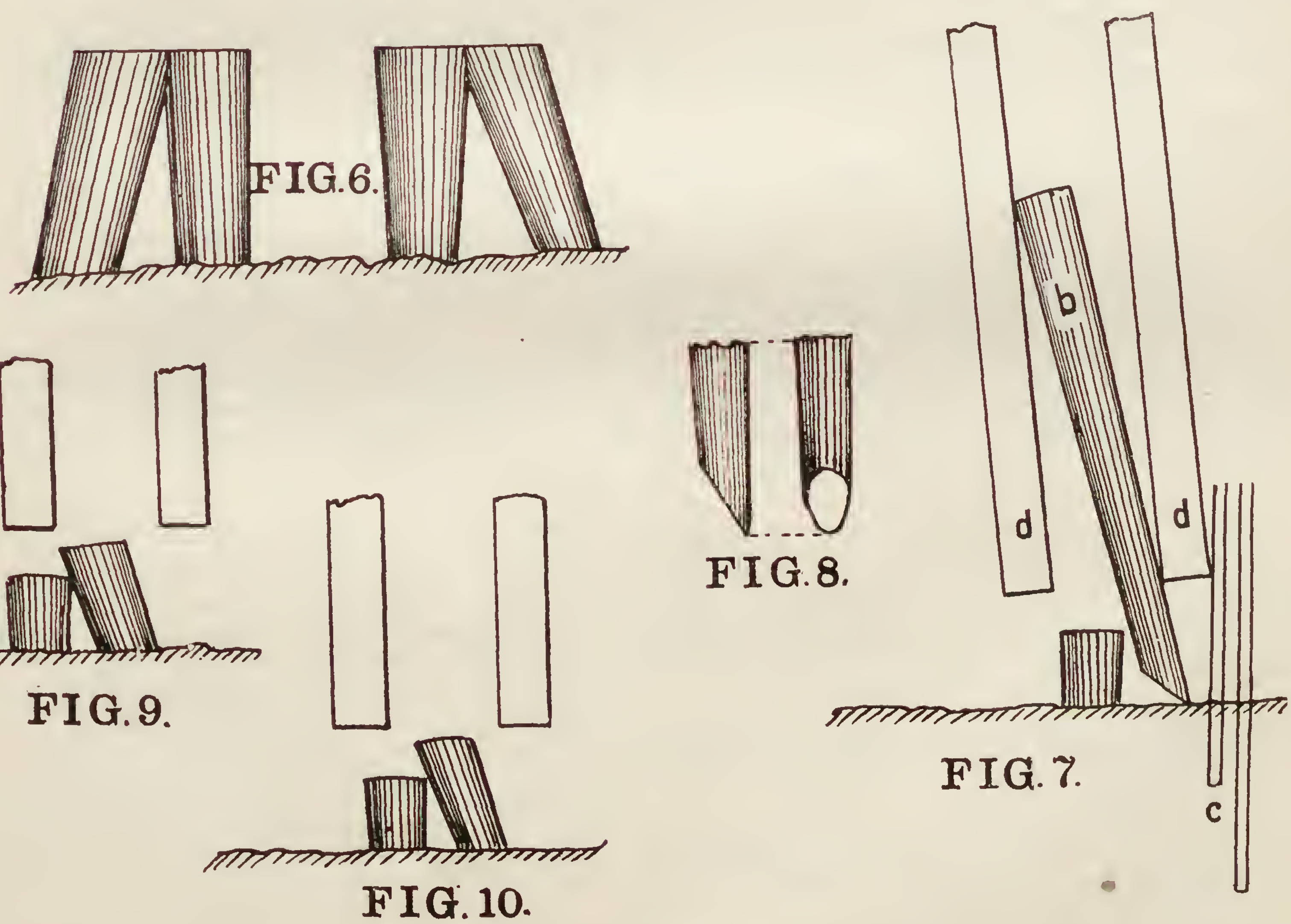
Meanwhile the pile followed the jets down, proceeding very closely with them. The piles went down about 6 ft. with this setting of the water-jets; after which they were pulled up and again sent down quartering as before. One jet was now kept about 3 or 4 ft. in the ground, while the other one was forced down to the bottom of the pile, it being made to go down gradually, accompanying the pile in its descent. After the pile had gone down about 10 ft. both jets were run down to the clay, then gradually brought up to the surface, completely loosening the sand through its whole depth. Not until this was done was the pile struck at all. A few light blows then sufficed to carry the pile down to the clay; after which it was driven by 4-ft. blows of a 3,300-lb. hammer, giving a blow of about 150,000 lbs.

The water-jets were kept in use, one at top of ground, the other at bottom of sand, being alternated by occasionally moving one up and the other down. This was done until the pile was within 4 ft. of being driven home; after which both jets were removed and the water stopped. The sand now settled closely around the pile at top of ground, and served to steady it while being driven home by very heavy blows of the hammer, drops of 12 to 15 ft. being used.

In driving spur piles it was found that they went down better if the water-jets were removed after the penetration of 15 ft. had been reached. It was not possible to strike a blow fair upon the end of the spur pile owing to the angle at which it must necessarily be driven. By removing the water-jet when nearly down, the backing of the sand at surface of the ground served to steady the pile, making its driving easier than when the use of the water-jet was continued. Several piles accidentally were driven 8 or 10 in. out of line by attaching the back fall of tackle of the pile-driver, and after getting a good strain upon the pile the sand was loosened on the side to which it was to go by means of the water-jet. After thoroughly jetting as deep as possible a pull was given upon the rope tackle referred to, and the pile easily pulled into place.



DETAILS OF APPARATUS.



DETAILS OF ARRANGEMENT OF PILES.

WATER-JET PILE-DRIVING.

This being done, the water-jets were removed to the opposite side of the pile, and after stirring up the sand there it was allowed to settle around the pile. In 10 minutes it packed so closely that the pile did not move back over three-quarters of an inch when the rope tackle was cast off.

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

THE object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publications will in time indicate some of the causes of accidents of this kind, and to help lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with the information which will help make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a great favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in April, has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS IN APRIL.

Concord, N. H., April 1.—The parallel rods on a locomotive hauling a paper train on the Concord Division of the Boston & Maine Railroad broke near North Boscawen to-day. Both crashed through the cab, and one struck Engineer Wood on the left leg, cutting it off below the knee.

Montpelier, O., April 5.—A train on the Wabash Railroad coming east to-night was fired into 8 miles west of this city. Fireman Fred Smith received a bullet in his head and is fatally injured.

Sommerfield, O., April 5.—A passenger train on the Bellaire, Zanesville & Cincinnati Railroad jumped the track near Whigville this morning, and plunged over a trestle 40 ft. high. Eli Lucas, the engineer, was killed, and the fireman, Jesse Jones, was fatally hurt.

Windham Station, N. H., April 5.—A passenger train on the Nashua & Rochester Railroad ran into an open switch near the station here to-day. The engine rolled over and was badly wrecked, but the engineer and fireman escaped with slight injuries.

Philadelphia, Pa., April 6.—The failure of the air-brakes caused a switching engine to crash into the bumpers at the Reading terminal station this evening. The engineer was slightly hurt.

Sherbrooke, Que., April 8.—A passenger train on the Passumpsic Division of the Boston & Maine Railroad ran into a boulder near Smith's Mills, Vt., to-night. The locomotive was overturned, and the engineer and fireman were fatally scalded.

Middletown, N. Y., April 9.—A freight train on the New York, Ontario & Western Railroad was derailed by a washout at Jermyn this morning, and the fireman was killed.

Punxsutawney, Pa., April 9.—A freight train on the Buffalo, Rochester & Pittsburg Railroad went through a bridge a mile and a half north of here this morning. The engineer and fireman were buried in the wreck under the waters of Mahoning Creek. The recent heavy rains had undermined the foundations of the bridge.

Poughkeepsie, N. Y., April 13.—Edward Hill, an engineer on the New York & New England Railroad, was killed at Glenham to-day while coupling the engine to a freight car. The fireman backed the engine upon him, and crushed him to death.

Knoxville, Tenn., April 12.—The engine of a passenger train on the Southern Railway was derailed near Afton this afternoon. It plunged down a 15-ft. embankment, and the engineer, J. H. Swatts, was caught between the engine and tender and scalded to death.

Akron, O., April 13.—James G. Dice, an engineer on the Erie Railroad, was run over and killed by a fast freight train at Sherman to-day.

New Haven, Mich., April 13.—During a dense fog a train on the Buffalo, Rochester & Pittsburg Railroad ran into a washout near Sykes, Pa. Engineer Taylor and Fireman Shea were killed.

Manistee, Mich., April 13.—An engine of an express train on the Flint & Père Marquette Railroad jumped the track near South Freesoil this afternoon. The tender turned over on the cab, and so severely injured the fireman, Fred Graham, that he died from the effects. Engineer Sherman had his arm broken and was severely bruised.

Plattsburg, N. Y., April 15.—An express train on the Delaware & Hudson Railroad was wrecked by a washout near Port Kent this morning. Engineer Rich was severely injured.

Chicago, Ill., April 16.—The engineer and fireman of a switching engine on the Chicago & Eastern Illinois Railroad were attacked and robbed by three men to-day. Engineer Bigelow was shot in the head when he raised an alarm as the robbers were escaping.

Dayton, O., April 18.—A passenger train on the Ironton Branch of the Chicago, Hamilton & Dayton Railroad ran into an open switch in the city yards this morning. Engineer Harry Kline was slightly injured; his fireman, William Smith, jumped and was internally injured, possibly fatally.

Mansfield, O., April 20.—There was a collision between a passenger and freight train on the Baltimore & Ohio Railroad, at Fredrickstown, 20 miles east of here, to-night. The engineer and fireman of the passenger train are fatally injured.

Spokane, Wash., April 21.—A freight train on the Northern Pacific Railroad struck a cow on the track near Garfield this afternoon. The engine then jumped the track, instantly killing Thomas Eckersly. The fireman was thrown into an adjacent field and seriously injured.

Portland, Me., April 22.—A freight train on the Grand Trunk Railroad broke in two to-day on a down grade near Norton's Mills, Vt. The engineer ran the forward section away from the detached cars, but while he was standing between the tender and the front car, the second section crashed into the rear end and killed him.

Banger, Me., April 29.—There was a wreck on the Bucksport Branch of the Boston & Maine Railroad this evening. Fireman John Arthur was caught in the *débris* and so severely injured that he died from the effects thereof.

Our report for April, it will be seen, includes 20 accidents, in which 10 engineers and 10 firemen were killed, and 7 engineers and 2 firemen were injured. The causes of the accidents may be classified as follows:

Air-brake failure	1
Break-in-two	1
Broken parallel-rod	1
Cattle on track	1
Collision	1
Coupling cars	1
Derailments	3
Landslide	1
Misplaced switches	2
Run over	1
Train robbers	2
Unknown	1
Washouts	4
Total	20

PROCEEDINGS OF SOCIETIES.

Engineers' Club of Philadelphia.—At the meeting of May 18 Mr. James R. Maxwell, a visitor, presented a paper on Railway Construction in the Peruvian Andes.

After briefly describing the area and natural characteristics of Peru and its population, the principal cities were enumerated and the character of the Andes Mountains was fully described.

There are no public roads in the country on which vehicles can be used except in the vicinity of Lima, the old roads made by the Incas all over the part of South America that they controlled being only for foot passengers and llamas. They were generally well arranged for grade, but the location was often bad. The Spaniards made little improvement in roads, although they built some good stone bridges over the larger streams. There is a good wagon road from Lima to Callao, and these were all the ways of communicating with the interior until about the middle of this century, when the first railroad was built. It extended from Callao to Lima—about $7\frac{1}{2}$ miles—was used for passengers only, and was very profitable. The work on it was light, and the total cost not over $150,000. Another road was built from Lima, about 8 miles long, to Chorillos, a summer resort on the Pacific Ocean.

Late in the sixties the Peruvians saw how the Chilians were opening up their country with railroads, and became anxious

to develop their own in the same manner. The government had a large revenue from the sale of guano, of which it had a monopoly, and so it easily floated a loan in England and organized a system of public works. A number of roads were projected, several of which were to cross the Andes, but the greater number were only local, reaching in from the coast to some productive locality.

A survey made to ascertain the expense of extending the railroad from Mollendo to Islay, only 6 miles along the coast, showed that it would cost $1,500,000.

The Board of Public Works, composed of engineers—some educated in this country, but most of whom had studied in Europe—fixed the standards for maximum rates of grade, minimum radii of curves, minimum length of tangents between the curves in opposite directions and the rate of compensation on curves, with some of the details of construction. The maximum grade was fixed at 4 per cent. On curves of 120 metres radius the grade was fixed at 3 per cent., while with 600 metres radius no compensation was required, and between these limits the rate was made proportional. The minimum length of tangents on curves turning in opposite directions was made 30 metres. The standard roadbed was 14 ft. wide; cuts, 16 ft. at sub-grade; through bridges, not less than 14 ft. in the clear; tunnels, 15.75 ft. at the springing line of the arch and 18 ft. high inside; minimum thickness of masonry lining, 16 in. The gauge of most of the roads was 4 ft. 8½ in., but there was one road of a metre gauge and a small one of 3 ft. 6 in. The contracts for most of these roads were let in 1869.

Mr. Maxwell then described in detail the construction of the roads from Chimbote up the valley of the Rio Santa, 165 miles, to Recuay, and the southern system, the largest in Peru, consisting of the road from Mollendo, 107 miles, to Arequipa; from there, 218 miles, to Puno, and another, from Juliaca, 210 miles, to Cuzco, of which only 112 miles are finished. The road from Juliaca runs nearly due north and crosses the summit of the eastern range at an elevation of 14,200 ft. When finished, the lowest elevation on the Cuzco branch will be 10,050 ft. above tide.

The most celebrated of the roads is the Ferro Carril Central del Peru. Starting at the docks in Callao, it keeps rising until, at 106 miles from the coast, it reaches a height of 15,666 ft. (about that of Mount Blanc). It then descends, and in 30 miles falls 3,489 ft. When completed 264 miles farther, it will reach the navigable waters of the Amazon, and this extension will probably not cost more than half as much as the finished portion. There are eight switchbacks on this road, four of them being double. There are 57 tunnels in a distance of 24 miles, mostly through rock spurs. Work was begun on this road in 1870, the track being laid to Chicla in 1875. It was resumed in 1890, and track was laid into Oroya on June 10, 1893. All of this work was done at an altitude above 12,000 ft., the most difficult and important of it, containing the two largest bridges and eight of the tunnels being above 15,000 ft.

OBITUARIES.

Frank Scott.

Mr. Frank Scott, the Vice-President and Treasurer of the Damascus Bronze Company, died at his home in Pittsburgh on the evening of Saturday, April 20. Mr. Scott was born in Pittsburgh on October 6, 1857, and has passed his whole life in that city, where he has made a name for himself as an energetic and capable business man. In his position as Vice-President and Treasurer of the Damascus Bronze Company, and as senior partner of the firm of Scott & McLean, iron brokers and dealers, he had made many warm business friends. Mr. Scott was not married, and had always made his home with his mother.

Arthur Mellen Wellington.

Mr. A. M. Wellington, the well-known civil engineer, died in New York City on the evening of Thursday, May 16, from heart failure following a surgical operation. He had been an invalid for over a year from a chronic affection of the kidneys, and an operation was performed on May 15, with the hope of relieving it, but with fatal results.

Arthur Mellen Wellington was born in Waltham, Mass, December 20, 1847, and was descended from an old New England family, which had resided in Lexington, Mass., for more than a century. He was educated at the Boston Latin School, and studied civil engineering in the office of John P. Henck, of Boston. He was engaged for more than 20 years in miscellaneous engineering work, principally upon railways, and including the Blue Ridge Railway, in South Carolina; the Dutchess & Columbia Railroad, in New York; the Buffalo, New York & Philadelphia Railroad; the Michigan Midland Railroad; the Toledo, Canada Southern & Detroit Railroad, and the New York, Pennsylvania & Ohio Railroad. In 1881 he was made Chief Engineer of the Mexican Central Railroad, and he spent the three years following, until 1884, in the service of the principal Mexican railways. He was Chief Engineer of the Interoceanic Railway, from Vera Cruz to the City of Mexico and the Pacific Coast, and the Assistant General Manager of the Mexican Central Railway.

As a result of his wide experience in railway location, he published in 1877 a treatise on the subject, which soon attained a wide popularity. In 1884 he turned his attention to technical journalism, and after two years' service as an editor of the *Railroad Gazette*, he became in 1887 one of the editors-in-chief and proprietors of *Engineering News*. The remainder of his life was spent in this work, interrupted only by service as Consulting Engineer to various enterprises.

He published his first work, "The Computation of Earthwork from Diagrams," when only 24 years of age. The first edition of his most important work, "The Economic Theory of Railway Location," was published in 1877. In 1887 he published a revised and much enlarged edition of this work, and it soon became the standard treatise on that subject. He was also the author of various minor technical books.

He was a member of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the Canadian Society of Civil Engineers, the British Institution of Civil Engineers, and the Engineers' Club of New York City. He contributed many important papers to the published transactions of these societies, and was widely noted as an authority.

In 1892 Mr. Wellington became interested in the subject of thermodynamics, and as the result of his studies he invented an entirely new system of transforming heat into mechanical work, designed to effect this transformation with a much smaller percentage of loss than the best existing steam engines. He devoted his best energies to the engrossing task of developing this invention, and labored so incessantly that his health failed under the strain imposed upon it. He had practically completed his invention, however, before this time, and was only awaiting the hoped-for restoration to health to undertake its commercial development.

Mr. Wellington married Agnes Bates, a sister of Major Alfred E. Bates, U. S. A. His wife and a daughter survive him.

Manufactures.

PINTSCH VERSUS ORDINARY ILLUMINATING GAS FOR CAR-LIGHTING.

The Safety Car Heating & Lighting Company have installed a very interesting exhibit in their office at 160 Broadway, New York. They have two tanks, one of them filled with compressed Pintsch gas and the other with compressed city gas. These tanks are connected with burners of various kinds in such a way that either kind of gas can be turned on at will. With any of the burners the Pintsch gas gives a brilliant light. As soon as the street gas is turned on the light at once begins to languish, and fades away until less than a third as much light is emitted, giving a very inferior illumination.

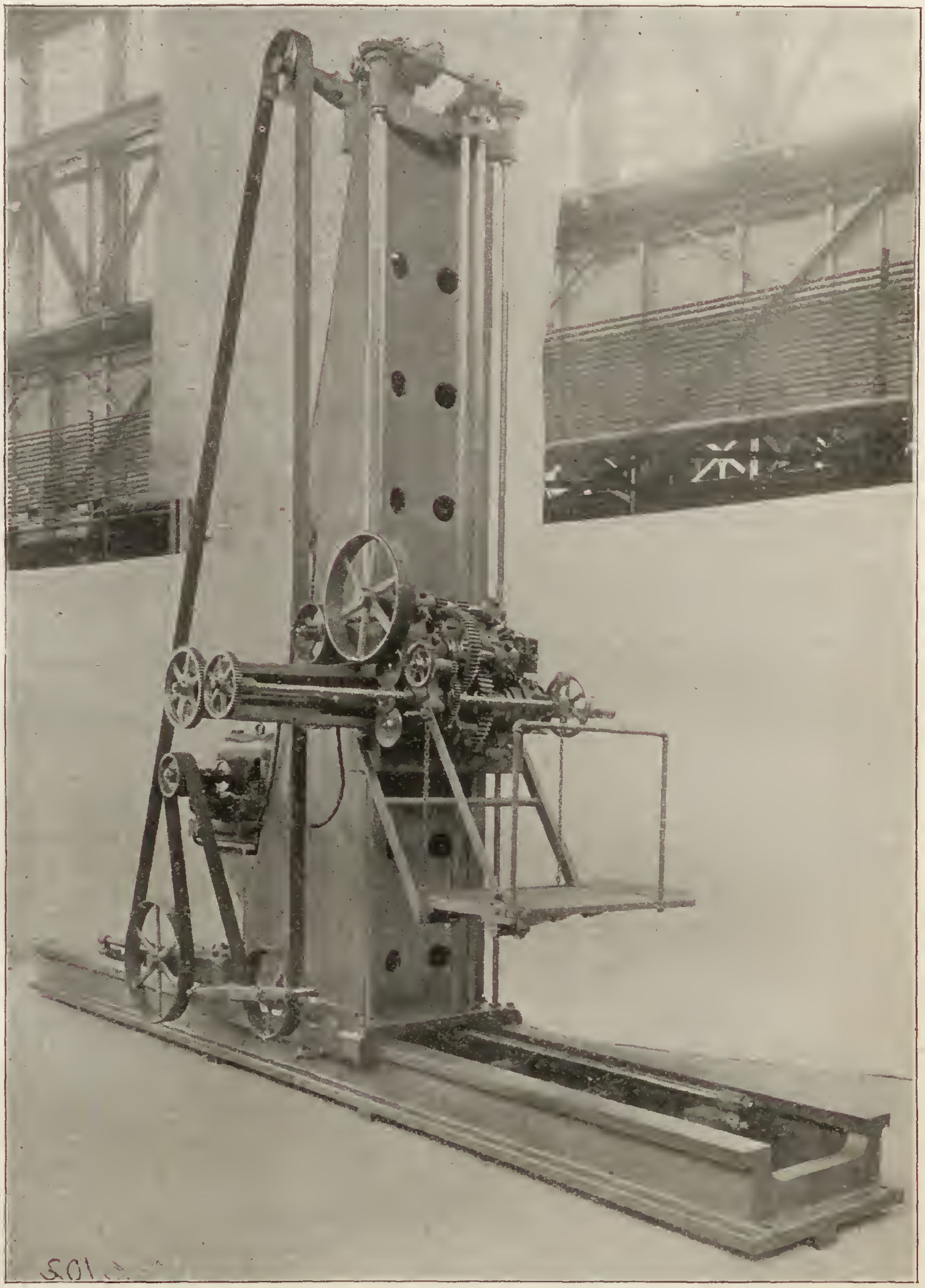
A new inverted burner is also exhibited which is not affected by drafts, such as are liable to blow out most of the lights of this character. This enables the products of combustion to be carried out of the car by a flue, whereas many burners of this class have no direct connection with "out of doors."

HORIZONTAL DRILLING, TAPPING AND STUD-INSERTING MACHINE.

In our last issue we published a short description of the electrically driven tools that are in use in the shops of the Southwark Foundry & Machine Company's works, in which an allusion was made to a milling machine that was built by the firm of William Sellers Company. Through the courtesy of this company we are now enabled to present an engraving of a similar machine, but without the milling feed and with a some-

what different arrangement for driving, that is in use at the yards of the Cramp Ship-building & Engine Company.

This horizontal drilling, tapping and stud-inserting machine is capable of operating vertically upon a surface from 3 ft. to 14 ft. above the floor, and 16 ft. horizontally, the whole upright carrying the machinery travelling upon the bed shown. This bed may be increased in length any reasonable amount desired, thus prolonging the horizontal travel accordingly. The drilling-head carries all the operating machinery, as well as the platform for the operator, so that whether the machine is working in its highest or lowest point, or anywhere along the bed, all the movements of raising and lowering the drilling head or moving the column horizontally may be made from the platform, quickly or slowly at will, and with the greatest nicety. The machine is driven by an electric motor carried on a bracket upon the back of the column (or it may be driven entirely by belt), and the electric system is such as to give 30 speeds forward and 30 speeds backward, a range so great as to adapt it for any class of work. The horizontal movement of the column upon the bed and the vertical movement of the drilling head upon the column are capable of a maximum of 20 ft. per minute, and thus permit rapid adjustment. This is done by means of the horizontal and vertical screws, the former being fixed. The belt system from the motor includes a tightening frame, so that the belt is always in proper tension whether the drilling head is at the top or bottom or at any intermediate point. The feeds to the spindle are given through the Sellers well-known friction disks, and in two series for fine and coarse, with a wide range to each, the maximum being about ½ in. per revolution of spindle. Particular attention is called to the fact that the power is not transmitted through long shafts, but is applied directly by the belt to the drilling head, the two square shafts shown being simply for engaging and disengaging the clutches for the vertical and horizontal movements. There is, therefore, an entire absence of the torsional strains in the long transmitting shafts used in other machines. The levers to manipulate the horizontal and vertical movement of the drilling head, and to engage and disengage the feeds, start, stop and reverse the driving mechanism, are grouped so as to be handled by the operator from one position, and the handles to manipulate the spindle are also grouped, thus permitting the largest possible product. As we have said, it is a similar machine incorporating milling feeds that is in use in the Southwark shops, the importance of which, in combination with the great range of speeds mentioned, will be appreciated. The operator's platform is carried by a swing frame, so that as the head approaches the bed the platform accommodates itself to the lowest point.



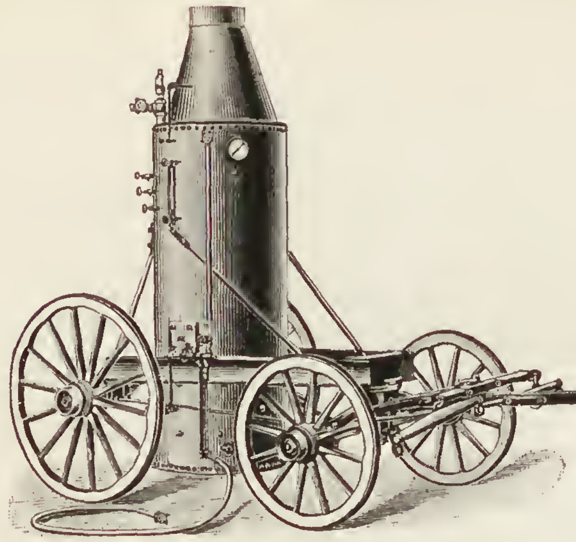
HORIZONTAL DRILLING, TAPPING AND STUD-INSERTING MACHINE.

A NEW STYLE OF PORTABLE BOILER.

The engraving shows a new style of portable boiler, mounted on road wheels, so that it may be easily moved from place to place, recently put upon the market by the W. A. Crook Brothers' Company, of Newark, N. J.

It is designed to do away with the long connections of steam pipe heretofore necessary in carrying steam considerable distances through pipes to rock drills, hoisting engines, steam pumps and other machinery, which has always been an expense and inconvenience. By the use of this new style portable boiler the steam generator may be brought close to the work. The cut is to a great degree self-explanatory. It shows a vertical tubular boiler which is mounted upon broad-tired road wheels in a very substantial manner. The machine is furnished complete with a pole and whiffletrees. The whole

outfit is light, and can, it is claimed, be hauled over the roughest of roads without any danger of breaking down. Sixteen



A NEW STYLE OF PORTABLE BOILER.

sizes are furnished, ranging from 5 H.P. to 75 H.P. Up to 18 H.P. three or four men can push the machine about very easily.

THE COMBINE WATER-TUBE BOILER.

The combine safety water-tube boiler, illustrated in this issue, is patented and manufactured by L. M. Moyes, 411–413 Walnut Street, Philadelphia. The boiler is "sectional" and of the class of the water tube type, in which the steam and water drums are arranged and located transversely to the flow of gases from the furnace to the outtake to the chimney. The illustration shows (fig. 1) transverse sections through the front steam and water drum and furnace, and through the rear steam and water drum. Fig. 2 shows a detail of "tubes," "manifolds" and "distributing drums" assembled. In elevation (fig. 3) the boilers present a neat and compact appearance, the steam and water drums are encased in blocks of "makite" moulded to the radius of drums, the bench formed by the break in the lines of brickwork in the rear of rear steam and water drums, as shown in elevation, is utilized for the carrying of the main flue, with a number of batteries, or the stack, with one battery or one boiler, reducing very considerably the floor space required. The fronts of boilers are of cast iron and are supported entirely free of the brick-work around boiler; the frame upon which the steam drums rest is formed of I beams braced and tied so as to be self-supporting, and is also independent and separate from the brick-work. The side elevation presents a fairly good idea of the arrangement of the boiler, the tubes (standard 4 in. × 18 ft.) on an angle of about 45° are expanded at the upper end into the tube-sheet in the steam-drum, and the lower end into the tube seats in manifolds. The manifolds for power plants are open hearth cast steel, thoroughly annealed, each manifold having an area almost equal to an 8-in. tube. Opposite each tube is a hand-hole closed with an inside and outside plate of steel; the seat on outside face of the manifold and face of the outside plate are machined so as to form a perfect joint without packing. The inside plate also forms an almost perfect joint without packing. Each manifold is connected to the distributing drum by a 5-in. nipple, and for ordinary high pressure the distributing drums are also of annealed steel. The sections are connected to and with each other by circulating tubes set at the same angle as the tubes, and are 5 in. in diameter. Each distributing drum has a separate blow-off valve. In the working of boiler the gases, as will readily be seen, have a very long contact with the heating surface in their flow from furnace to outtake. As is indicated by the arrows, the circulation of water and flow of steam generated in tubes is upward in the two forward sections into the two front drums, with ample disengaging space, thence by the connecting devices to the rear drum, into which the feed is also delivered and downward in the rear section. The ingenious and mechanically designed connections between sections provide for all expansion strains. The steam drums rest on I-beams in such manner as to remove all carrying strains from the tubes.

The transverse section through the front steam drum shows the separator dry pipe in each drum. The section through rear drum shows the feed-water sumpt. The feed pipe is connected to the sumpt, and into it the feed water is delivered. This sumpt is of cast iron, on which a light cast-iron cover is loosely placed, and which continues to within a short distance of the end of the sumpt, forcing the feed to travel its entire length, and in doing so acquiring the temperature of water in circulation in the boiler before coming in contact with the same, thereby depositing many of the impurities in solution and suspension, which are removed by the use of the blow-off valve attached for that purpose. Should the deposit in the sumpt accumulate through inattention to such an extent as might interfere with the passage of the feed through sumpt, the cover being placed on loosely would be forced off by the accumulating pressure, due to the feed delivery, and thus enable the feed to enter into the circulation. The circulating and compensating tubes by which the steam drums are connected are shown in the side elevation, as well as the cross steam pipes on the top of the drums, to which safety valves are attached. These cross pipes are of steel with flanges cast on. A tube from any section in boiler can be easily removed without interfering with the adjoining tubes. The removal of a deposit from the inner surface of tubes is made either by introducing the scraper at the lower end through the hand hole, or at the upper end from the steam drum. The smallest steam drum used on this boiler is 42 in. in diameter, giving ample space for men to work in when cleaning the tubes. The chamber at the lower end is also sufficiently roomy for cleaning. The facilities for cleaning tubes has been based on the practice of many years' experience with this type of boiler. A specially designed scraper and handle is used. The cut of detail (fig. 2) shows the manner of connecting the tubes to the manifolds, as well as the connections between manifolds, and the connections between manifolds and distributing drums. The hand holes shown in the distributing drums are covered and protected in the same manner as those in the manifold, the same fittings being used in both cases. An important feature in the combine boiler is due to the possibility of shipping the boiler as an almost completed unit. Each boiler is shipped in three sections, the sections consisting of a steam drum, the tubes, the manifolds and the distributing drum. These are assembled and tested at the works,

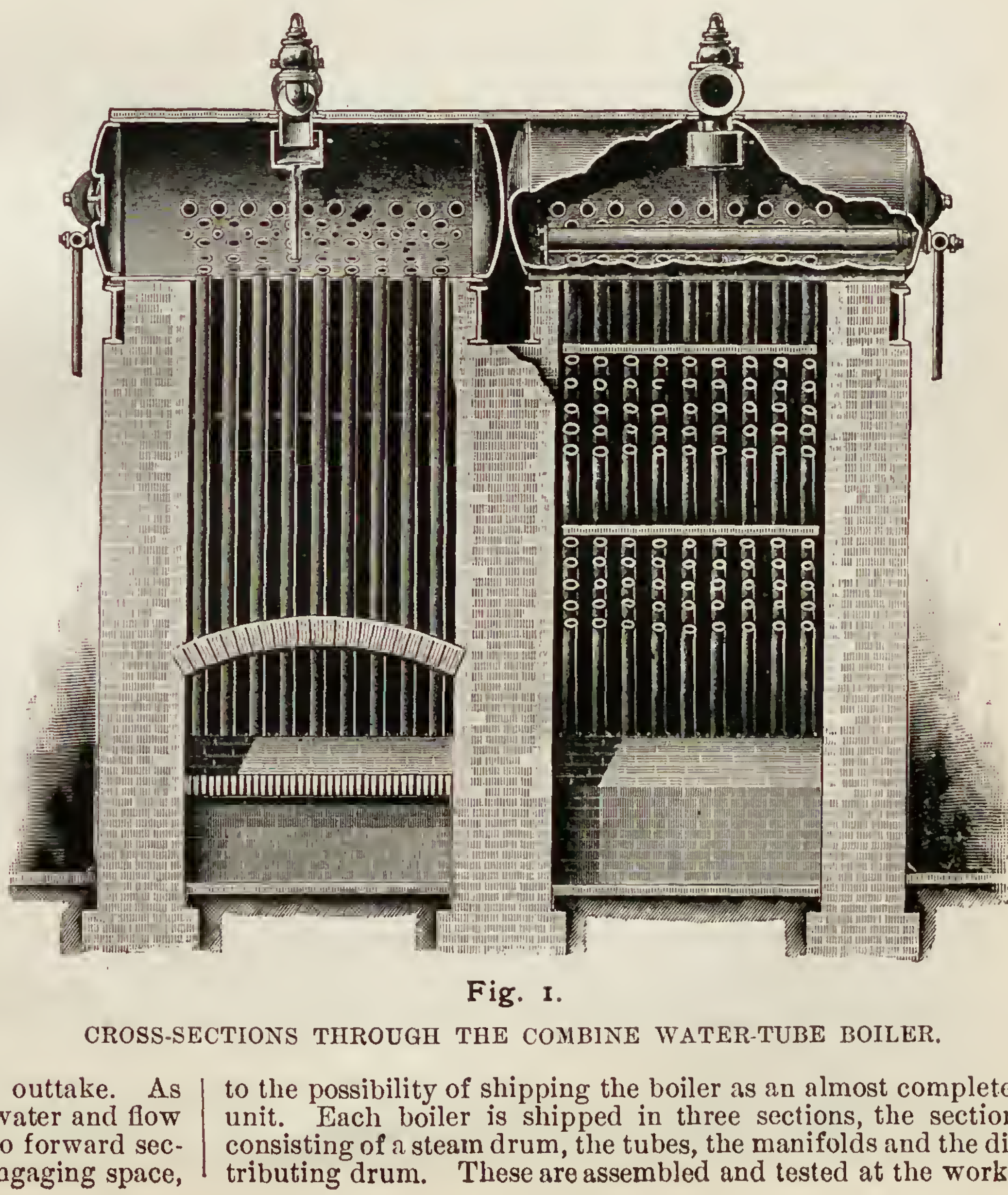


Fig. 1.

CROSS-SECTIONS THROUGH THE COMBINE WATER-TUBE BOILER.

only requiring the connecting of the same at the point of erection to form the perfect boiler. All sections are connected by ex-

Fig. 2.

DETAILS OF TUBES IN THE COMBINE WATER-TUBE BOILER.

panded tubes or nipples, there not being a single bolt or threaded connection in the entire combination. The tubes forming the heating surface are practically straight. The slight curve in the two tubes in each section made necessary for alignment in entering tube holes in the drums is practically done at the tube mills during the process of manufacture. The tubes with curved ends are in every respect interchangeable between the different sections. It will also be observed that there are no departures from the established lines of the standard boilers of the water-tube type. The assemblage of heating surfaces, the building up of the same with standard tubes, drums and manifolds, and their relation to each other, the travel of gases in contact with heating surfaces, the circulation of water and flow of steam due to the devices used are identical in their dispositions, as in the better-known boiler, with which Mr. Moyes was for so many years connected.

This takes the combine at once from out the ranks of the experimental class. The builder will make a specialty of boilers for power plants; but the combine is also adapted for office and other large buildings where sufficient head room for the ordinary boiler is at times a difficult problem to solve. Another very satisfactory feature in the combine is the fact that in price it is in direct competition with the return fire-tube boiler. It is built in units ranging from 50 H.P. to 600 H.P., and is capable of carrying a working pressure up to 200 lbs. per square inch.

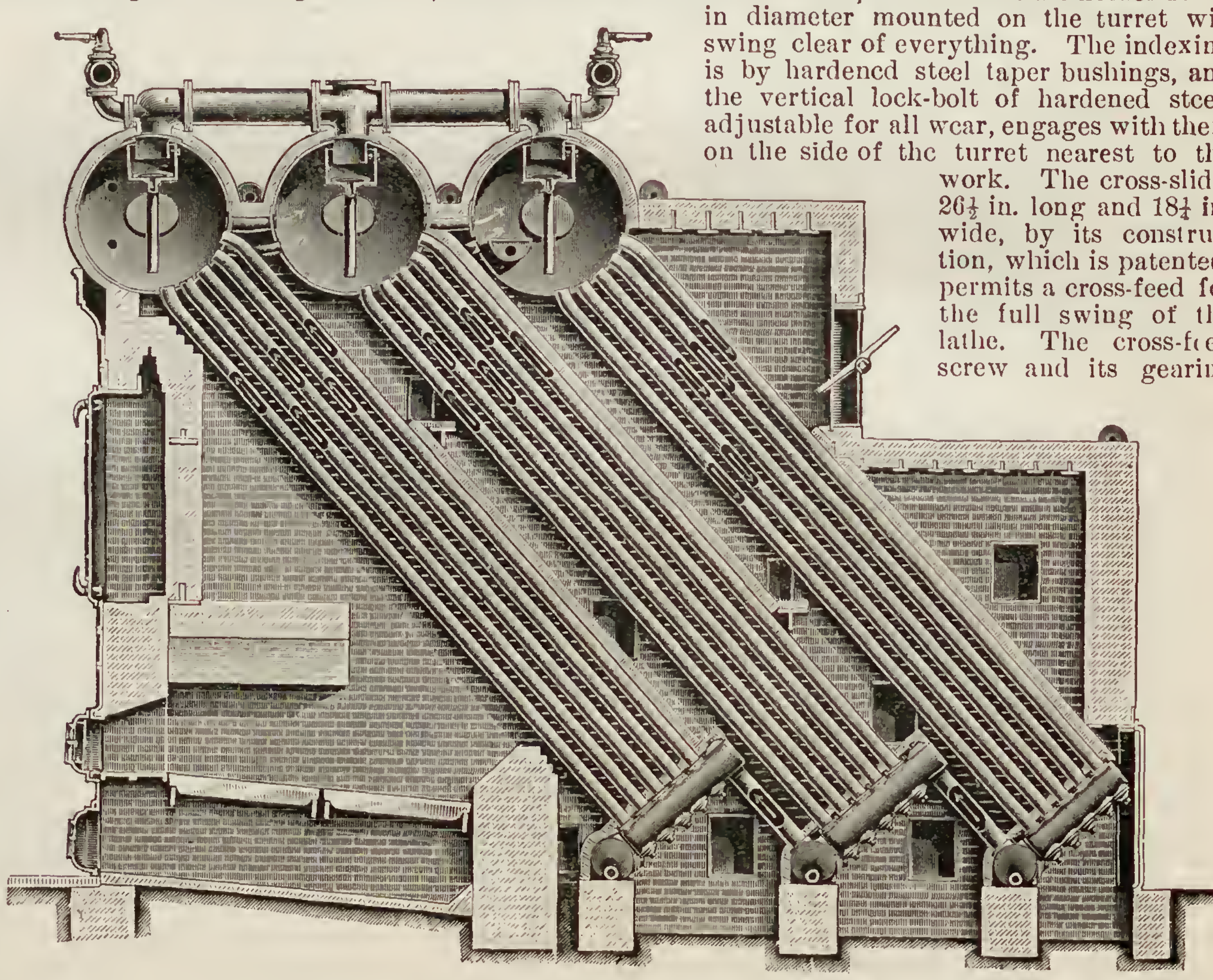


Fig. 3.

SIDE ELEVATION (BRICKWORK REMOVED) OF THE COMBINE WATER-TUBE BOILER.

BOGERT'S 28-IN. TURRET ENGINE LATHE.

THE two engravings herewith represent front and back views respectively of this machine, which has 28 in. swing and a bed 8 ft. long.

The head stock is fitted with boxes lined with nearly pure tin, and adjustable for all vertical wear. The front bearing is 4½ in. in diameter and 6½ in. long. The front cap is held and adjusted by four 1-in. bolts, and, like the back cap, is constructed with an oil-cup, for the continuous supply of the lubricant. The spindle of hard crucible steel has a 2¾-in. hole through its axis. The end thrust is taken by hardened steel collars ground perfectly parallel. The cone has four steps 4⅜ in. wide. The double back gearing is frictional, and has the two ratios of 5 to 1 and 25 to 1.

In the manufacture of large valves or heavy pipe fittings a great saving may be effected thereby, as with back gearing of 25 to 1 engaged there is ample power to pull pipe-taps up to 12 in. in diameter, and by shifting the lever as soon as the counter-shaft is reversed the pipe-tap may be backed out five times as fast as it went in. The whole back gearing may be also disengaged, and the cone alone will drive the spindle. By varying the respective sizes of the face-plate gear and the back-shaft pinion, any desired power or speed ratios may be obtained. This capacity for variation, to suit different conditions of work, is peculiar to this device, and it may be justly considered an important invention. Furthermore, the frictions being on the back-shaft, not inside the cone, are at all times open to inspection, oiling, or adjustment; and they can be so constructed that the greater the ratio of back gearing, the greater the surface of frictional contact.

The turret is 18 in. in diameter, usually made six-sided, and bored for six 3-in. holes. An open and shut die-holder 15 in. in diameter mounted on the turret will swing clear of everything. The indexing is by hardened steel taper bushings, and the vertical lock-bolt of hardened steel, adjustable for all wear, engages with them on the side of the turret nearest to the work. The cross-slide, 26½ in. long and 18¼ in. wide, by its construction, which is patented, permits a cross-feed for the full swing of the lathe. The cross-feed screw and its gearing are always protected from chips by a telescopic slide. The cross-slide anchor, 16 in. long, and secured by two 1-in.

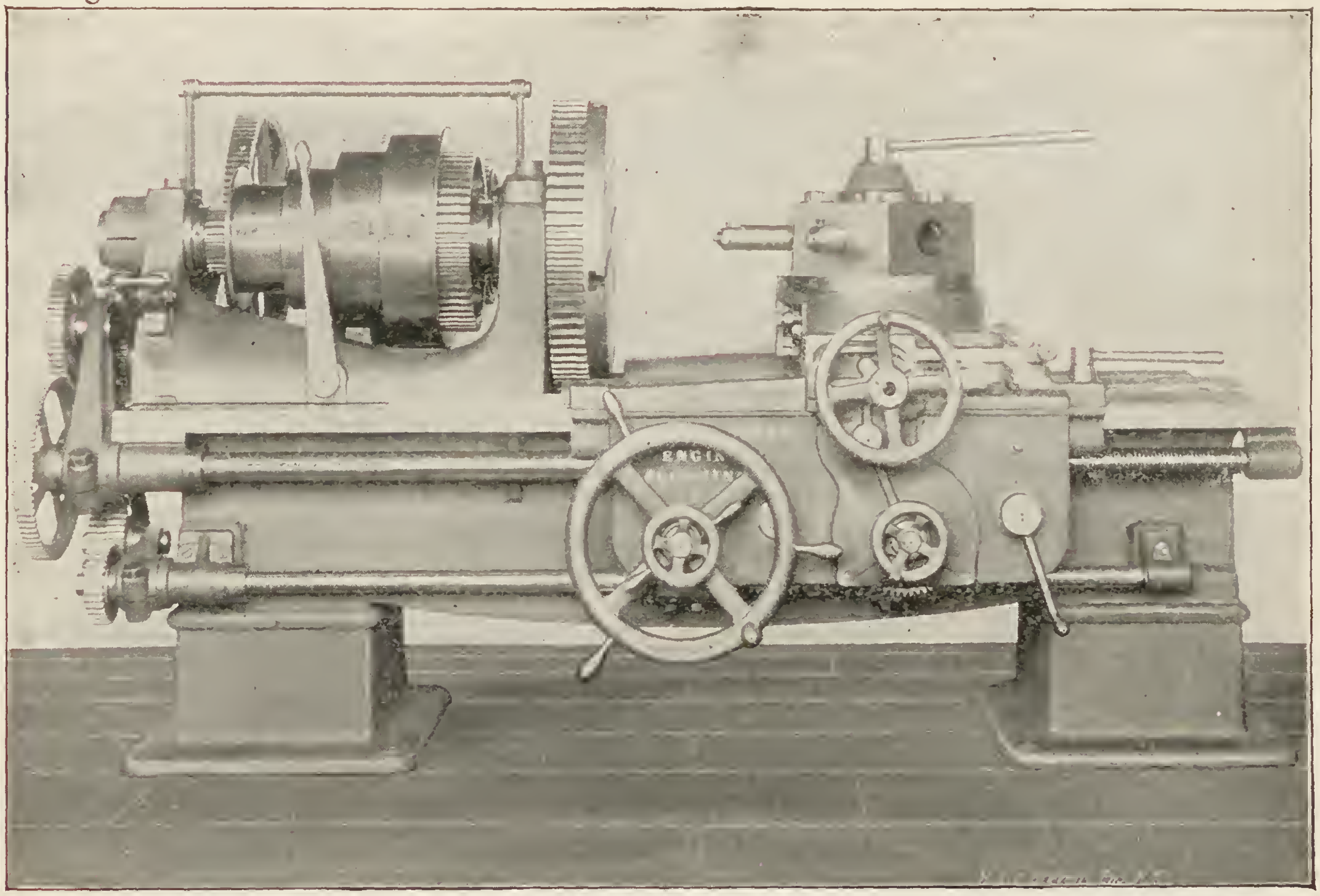


Fig. 1.—Front View.

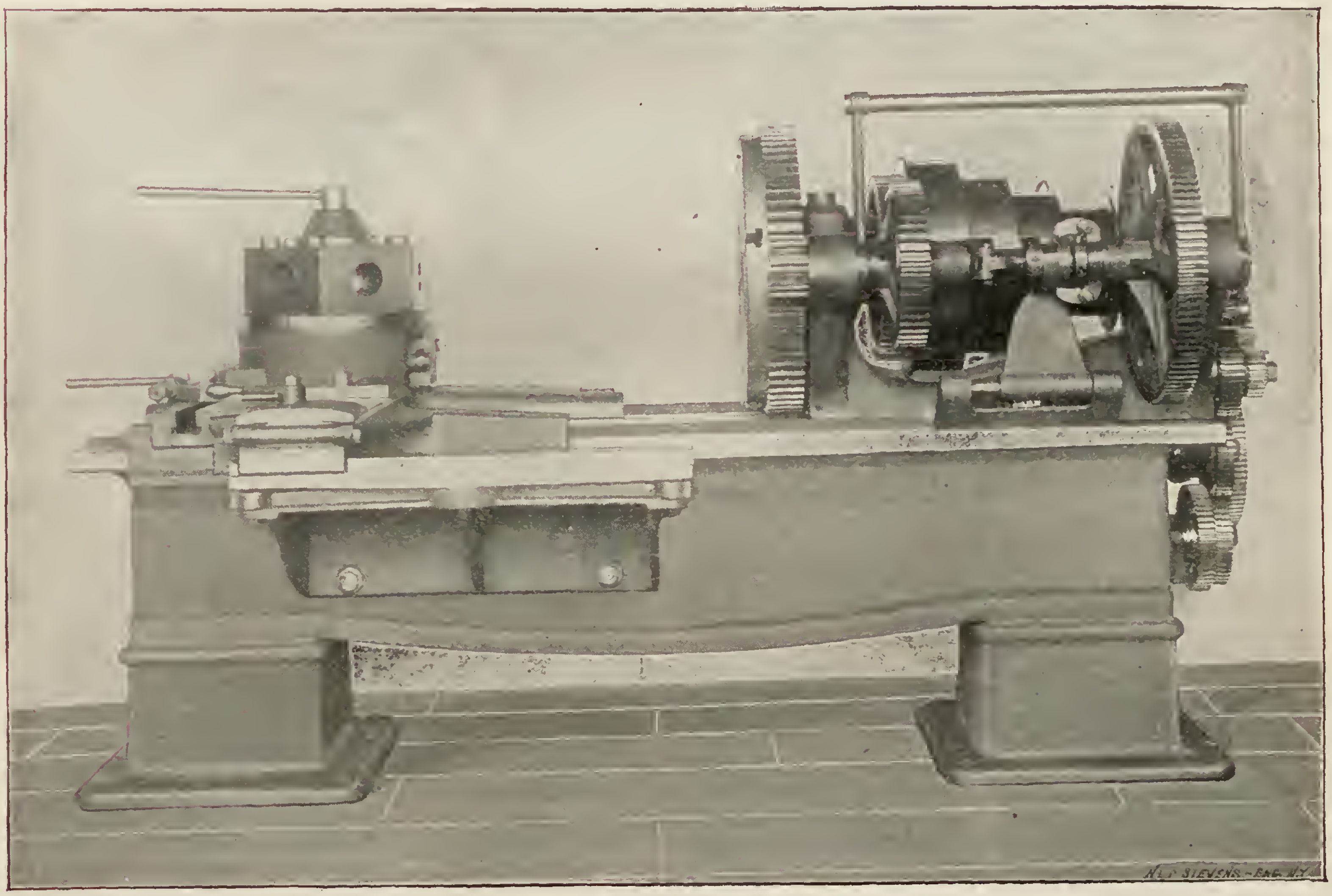


Fig. 2.—Back View.

BOGERT'S PATENT 28-INCH TURRET ENGINE LATHE.

bolts, eliminates all vibration between cross slide and carriage. Suitable stops permit the exact return of the turret tools into line with the spindle, and control their setting.

The carriage is 44 in. long, and gibbed to the front and back shear of the bed. The apron contains separate powerful friction gearing of phosphor-bronze for the longitudinal and cross-feeds, as well as the half nuts, which are used only when screw-cutting. By the lead-screw, which is $2\frac{1}{4}$ in. in diameter, with a suitable arrangement of change gears, any desired thread may be cut. The splined-rod which drives the power feeds may be geared to obtain a sufficiently coarse feed without disturbing the change gears operating the lead-screw ; this is an important detail, facilitating the rapid production of threaded work. The direction of all power feeds is instantly changed by the rocker-handle shown on the head stock. With the change gears regularly furnished the usual variety of threads from 1 to 16 per inch may be cut without compounding.

The taper-turning attachment, which is patented, is unique in this most important respect, that it is instantly engaged or disengaged by the movement of a single handle, making possible the boring or turning of contiguous straight and tapered surfaces without loss of time. The proper setting of the taper-bar, which is 36 in. long, is determined in the usual manner by a scale reading in thirty-seconds of an inch, to 4 in. taper per foot both sides of the centre line.

The counter-shaft is fitted with double patent friction pulleys 21 in. in diameter and 5 in. face. It should make from 160 to 200 revolutions per minute forward and backward. Whenever desired, special three and four-jaw chucks are furnished to facilitate the rapid handling of work.

The weight of the lathe with taper attachment is 7,500 lbs.; without, 7,000 lbs. These machines are manufactured by John L. Bogert, Flushing, N. Y.

McKEE SLACK ADJUSTER.

The brake adjuster, illustrated in the accompanying engravings, is the invention of Mr. M. E. McKee, of St. Paul, Minn , and is being manufactured and introduced by the Q. & C. Company, of Chicago.

This device embodies several novel features, the principal one being the use of an auxiliary or take-up cylinder actuated by air from the brake cylinder, which supplies the requisite power, and a screw-threaded pull rod and ratchet mechanism, by which the cylinder or floating level, as the case may be, is adjusted in position.

Several forms of this adjuster have been made, and the one illustrated has been proved by experience to be one of the most practical and efficient. Referring to figs. 1, 2 and 3, which show the adjuster as applied to a 10-in. passenger brake cylinder, the cylinder lever *A* is fulcrumed on the pin *B* and the jaw *C*. This pin slides in the slot in the malleable casting or stirrup *D*, which is bolted to the lever bracket on the cylinder-head *E*. The jaw is held in position by the screw-threaded rod *F*, on which is cut a square thread of $\frac{1}{4}$-in. pitch. The rod *F* is formed with a T end to engage with the jaw *C*, and passes through a hole in the end of the stirrup. A ratchet-wheel, *G*, with an internal thread in the hub works on the pull rod *F*, and is prevented from moving away from the stirrup by the small bracket *H*. A ratchet lever and pawl, *I*, are pivoted on the outside of the hub of the ratchet wheel, and are actuated by the piston-rod *K* of the take-up cylinder *L*. From the end of the take-up cylinder a $\frac{1}{4}$-in. pipe leads to the air-brake cylinder, which it enters at such a distance from the end that if the brake piston travels beyond the predetermined length, air is admitted through the small pipe to the take-up cylinder ;

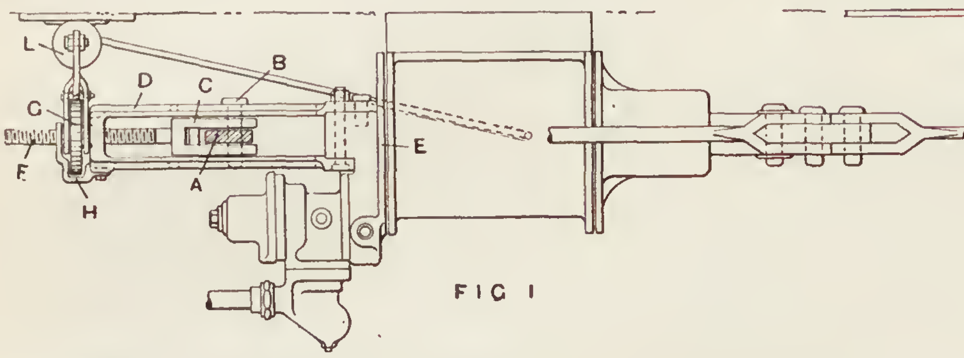


FIG I

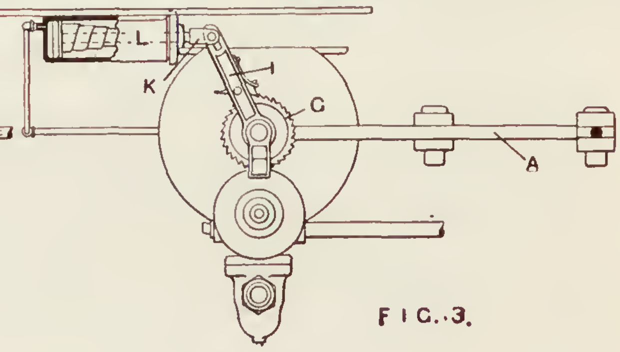
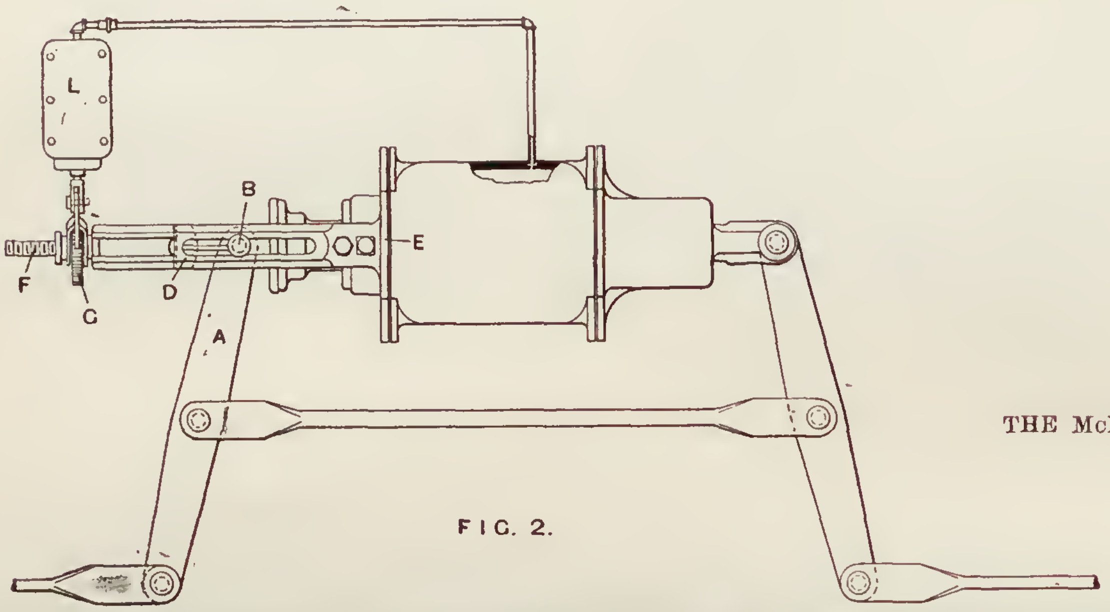


FIG. 3.



THE McKEE BRAKE SLACK ADJUSTER.

FIG. 2.

when this occurs the piston of the small cylinder is forced out, moving over the ratchet lever and rotating the ratchet wheel about one-eighth of a revolution. The screw thread of the ratchet wheel thus moves the pull-rod *F*, and with it the end of the cylinder lever *A* $\frac{1}{32}$ in., which insures a fine and regular adjustment of the brakes and a frequent action of the mechanism.

When the brake is released, the air from the take-up cylinder escapes through the back-head of the brake cylinder and the piston is forced back by a spring into position for another stroke. It is obvious that the brake piston can be adjusted to any desired travel by varying the location of the port by which the $\frac{1}{4}$-in pipe enters the brake cylinder, and that once the length to which the stroke is to be adjusted is fixed, it cannot be altered by any tampering with the adjustment.

After three years' careful experimenting the form here illustrated has been adopted on account of its advantages of simplicity, decreased cost, both for application and maintenance, its comparative immunity from dirt and snow, and accessibility.

Since only $\frac{1}{32}$ in. slack can be taken up at one application of the brakes there is no liability for the piston travel to be shortened by an emergency application to such an extent that binding the shoes on the wheel while running might recur.

No practical objection whatever has been found in three years' regular service against adjusting the piston travel at the cylinder lever or for freight cars at the floating lever, and the adjusters illustrated above have been in use on passenger and freight cars on the Great Northern Railway, running both on short distance and trans-continental trains, in the latter service having been through snow blockades in the Cascades and the sand and dust of Northwestern summers in the Dakotas, and have so far never cost a cent for repairs or failed to perform the work in any particular. There is nothing in this device which is liable to get out of repair ; the only part ever needing renewal being the packing leather in the small cylinder, and this has not yet been the case in any of the adjusters so far in service.

AERONAUTICS.

UNDER this heading we shall hereafter publish all matter relating to the interesting subject of Aerial Navigation, a branch of engineering which is rapidly increasing in general interest. Mr. O. Chanute, C.E., of Chicago, has consented to act as Associate Editor for this department, and will be a frequent contributor to it.

Readers of this department are requested to send the names and addresses of persons interested in the subject of Aeronautics to the publisher of THE AMERICAN ENGINEER.

A NEW PARACHUTE.

WE find in a recent issue of *La France Aérienne* the design for the application of a parachute to a balloon illustrated herewith. It is the invention of M. Emil Picq, a young aeronaut, lately deceased, and is intended to save ballast as well as to serve as a parachute in case of accident to the balloon.

It is well known that when the contained gas cools in the higher regions of the atmosphere the balloon descends, and ballast has to be thrown out in larger quantities than those just sufficient to restore the equipoise, for otherwise accelerated velocities would result. The descent once stopped, the balloon immediately rises again, and (the whole system being lighter) to a point generally higher than that previously attained, so that gas has to be let out to compensate for the previous loss of ballast. A balloon journey, therefore, consists of a series of ascents and descents, and alternate losses of ballast and gas until the supply of the former is exhausted.

M. Picq proposed to remedy this partly, and to lengthen the time of the journeys, by applying the parachute above the balloon, as shown in fig. 1, his idea being that if a decided descent sets in, the parachute will open as shown in fig. 2, and by increasing the resistance enable the aeronaut to arrest the downward movement by throwing out a much smaller quantity of ballast than would otherwise be required. A corresponding amount of gas would thus also be saved, and the upward oscillation would be diminished.

Whether in actual practice so limp and flabby a surface as that of the parachute could be relied upon to open and close symmetrically, as shown in the figures, can only be told by actual experiment.

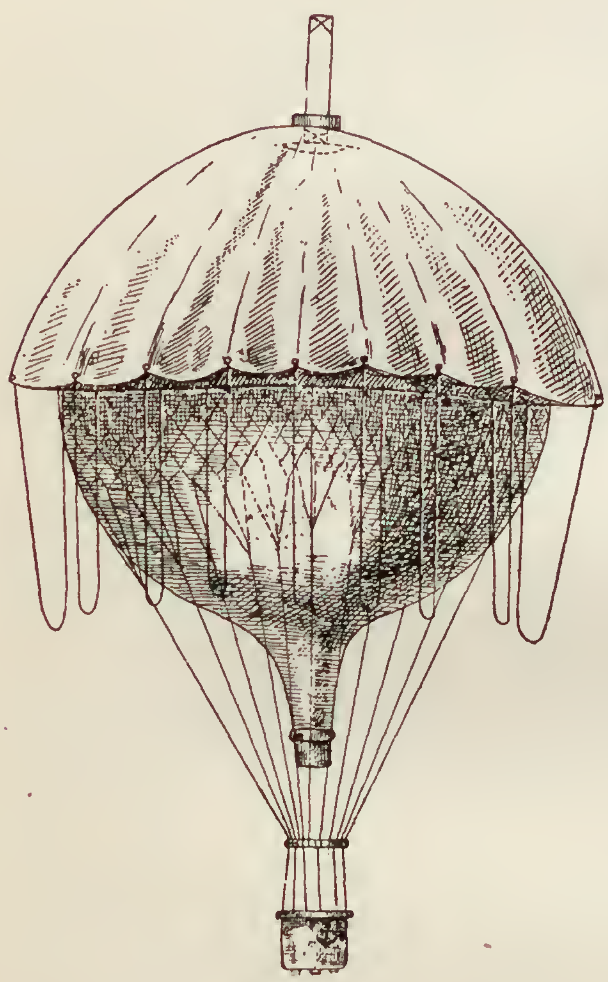


Fig. 1.

Fig. 2.

A NEW PARACHUTE.

THE VALUE OF METEOROLOGICAL OBSERVATIONS AT HIGH ALTITUDES.

DIMINUTION OF TEMPERATURE WITH ALTITUDE.

To the Editor of THE AMERICAN ENGINEER :

There have been few questions in meteorology of so great importance as this of the distribution of heat in a vertical direction in our atmosphere. There is very little doubt that the hot wave ushering in a storm at the earth's surface is of cosmical origin, and extends to the limits of our atmosphere. Precisely the same is true in the case of our cold waves. A great deal of misapprehension has arisen from considering that the front of these hot and cold waves is nearly vertical, while records on Mount Washington, Pike's Peak, and other mountains have shown that these conditions are far ahead in the upper air. At Mount Washington they are 24 hours ahead, although a part of this is due to a slightly greater insolation after the hot wave has begun at the earth and a greater heat radiation after the cold wave has begun.

A very careful study of records near the earth has established the law of diminution up to 1,000 ft., and now that accurate balloon observations are being greatly multiplied, we may hope to learn a great deal in regard to temperature conditions up to heights of 12 or 15 miles. The enterprise of Dr. A. Berson, in taking up a cylinder of oxygen and, by the inhalation of the gas, in reaching a height of 28,700 ft., marks an era in atmospheric exploration, and we may now expect an accurate determination of temperature, humidity, air currents, etc., at heights of 7 miles.

It should be remarked that weather conditions are so moderate in Europe and the motion of storms is so slight there that we cannot hope for an elucidation of the forces causing normal and extreme storms in this country by any number of records abroad. Storms or low-pressure areas in Europe have very slight intensity, the gradients of pressure are extremely small, and the motion of the low areas very erratic. This fact accounts for the greatly reduced velocity of low areas in Europe, only about half the velocity experienced in this country. High areas often remain stationary for more than

two weeks, and the pressure in these is very often much greater than ever noted in America. We may best call these conditions stagnant, and to such an extent is this true that the weather runs in types, a certain type of pressure distribution betokening a certain character of weather for a week or more. It is needless to remark that nothing of this kind is known here.

All this, however, does not detract from the greatest interest attaching to these efforts abroad. It has been shown already that the air currents up to 10 miles have very nearly the velocity of similar currents in this country, and this would seem to emphatically disprove the views of many who think that our storms are merely columns of heated air drifting in the upper current, and also of those others who imagine that our storms are whirls or eddies formed in a poleward moving upper current.

It has been well established that in clear weather the temperature, especially in winter and when there is little or no wind, rises in the early morning up to about 300 ft. The reason for this is very clear : intense radiation through a clear, still air cools the earth enormously, and this cooling affects the air immediately above the earth. Beyond 300 ft. there is generally a pretty uniform diminution of temperature, with altitude probably one-third greater in summer than in winter in the eastern and northern United States. This diminution is seldom greater than 1° in 250 ft., or less than 1° in 400 ft.

In cloudy weather, however, the temperature is either nearly uniform up to the clouds, or it may rise a little as we approach them. In the cloud itself, as we come into the sunshine, the temperature rises very rapidly, due to the intense heat of the sun upon the cloud. These principles are so simple and plain, that it is a matter of wonder that any one should be misled by any observations of this nature in balloons. In a balloon voyage at Providence, R. I., an account of which is published in *American Meteorological Journal* for November, 1891, p. 292, the temperature remained nearly stationary up to the cloud region 1,000 ft., and rose over 7° in the next 1,300 ft. From the top of the clouds up to 10,000 ft. the diminution in temperature was 1° per 409 ft. In this *Journal* for March there are given the records made by Dr. Berson in his memorable voyage in which he reached nearly 29,000 ft. In the descent, at the cloud level (4,600 ft.), he found the temperature 43°, while at the earth it was 34°. This experience was almost precisely the same as the previous one, except that the diminution in temperature was only 1° in 249 ft. above the cloud region. Dr. Berson's ascension was made about half-way between a "high" and "low," but nearer the latter, which will account for a part of this difference.

While there are certain fundamental laws established, we still need numerous records in the centre of storms and high areas and on all sides of them. Almost every ascension gives us something new, and we may hope before long to settle some of the questions which are so doubtful now.

H. A. Hazen.

May 4, 1895.

EXPERIMENTS IN AERONAUTICS.

To the Editor of The American Engineer :

Dear Sir : I have progressed so far in my experiments in aeronautics that I am building a machine that will contain 1 sq. ft. of sustaining surface to every 2 lbs. of weight to be lifted and carried. The wings are to be concavo-convex, and flexible from front to rear. They will be long and narrow, and vibrated on an incline down and forward and up and back. The power is to be applied by the feet of the operator, and equilibrium is to be maintained by elevating or depressing the back edge of the wing on either side with the hands. One wing can be depressed and the other elevated or *vice versa*, each wing independently of the other, to guide to the right or left, or they can be elevated or depressed simultaneously to steer up or down. To get the first start, I propose to elevate the machine on a tripod—the wings and tail might be made to act as the tripod—and then climb up to it by means of a rope ladder, then to fall down and forward, carrying the machine and tripod with me. The top of the tripod will act as a lever to throw me forward and down. While falling I propose to vibrate the wings with my feet, and guide or steer with my hands on a lever connected with the back part of the wings. Somebody may smile at this, but in the future I will endeavor to prove what I say. There are so many good people who *will* smile at an investigator in this branch of science, because it is funny to see a man dangling from a machine up in the air trying to do what almost everybody considers impossible. I find it hard work to keep myself in hiding, for a machine to fly has to be in the air, and when it is in the air it is in a position to be viewed by everybody in sight. It requires a good deal of nerve to go ahead under all and every condition of circumstances. In order to propel, I propose to carry my weight on the wings from a point up and back to a point down and forward. This carrying of the weight from back forward will assist in propelling ; then the flexibility of the wings will also assist in propelling. In the return or upstroke of the wing it will encounter some resistance from the air, striking its upper surface, which will also help to propel, but the most propelling force will result from the dropping of the front part of the machine during the up-stroke, and a consequent tilting up of the tail end, which will make us slide forward and down an incline ; then the down-stroke of the wing will again elevate the front end, and the process of again falling and sliding down an incline forward will be repeated. Now can we lift ourself higher in the down-stroke than we will fall during the up-stroke? I say we can, because the wing encounters greater resistance due to our advancing against the air, and in the up-stroke we are still getting an uplift, although the wings are moving up and away from the advancing air. Again, in the down-stroke our momentum, due to our advancing, will more than overcome the horizontal resistance which the wings, body, etc., will encounter in moving through the air. There will be more power required in the start than after we have sufficient head resistance to sustain us. I say head resistance, because that is just what we want and must have before we can ever hope to be lifted in the air. The wings must incline 20° to 35° to advance in order to get this resistance. I have read so often that the various birds require a velocity of 30 to 60 miles an hour to sustain them in the air, but I haven't seen anywhere the statement, which is also true, that these same birds start from a state of rest and *begin* to fly at velocities of 1, 3, 5, or 7 miles an hour, and they do it by vibrating their wings from back down and forward and from forward up and back, and their wings are always inclined to the direction of advance—*i.e.*, the front edge pointing above the horizon from 20° to 45° at the start, to 1°, 2°, or 3° in full flight, except in upward currents of the air, then the front edge points below the horizon. Their wings are inclined to advance at the start as much as a boy's kite when he starts to fly it. What would be thought of a boy who would persistently try to elevate a kite by holding it almost horizontal ? Yet we are trying to elevate a flying apparatus by so doing. Of course less power is required to advance when the plane is nearly horizontal, but how are we ever going to get a speed of 30 to 60 miles an hour on the ground unless it be a railroad-track ? We must begin to fly at speeds, like a bird, of 3 to 10 miles an hour or give it up, and leave the problem to be solved by those who can afford to build a smooth track, and who are willing to run the risk of a broken neck in coming back to mother earth at a 40-mile rate. A man can exert from 1 to 2 H.P. for a few seconds, and this is all that is needed to get a start. After he is once going, the power required will only be one-fifth to one-tenth of that required at the start, and when we have up-currents of air, which is invariably the case, soaring or sailing can be accomplished without any power whatever from the operator, save that which is necessary to balance and steer.

If each investigator in this department of engineering would make public his mite of knowledge on the subject, there is no doubt but that a solution would be arrived at in a comparatively short time. On the other hand, a man don't feel like giving away information which has taken him years to get without protection of some kind, and I think our Government makes a mistake in not issuing a patent on flying machines unless they "*do go*," for it is not likely that one man will solve the problem as a whole, but each one will have a part, and he should be able to protect himself in that part. As it is he is disposed to keep to himself all his attainments in this branch of science, and the world at large laughs at the individual, but I think if these individuals could make known to each other their separate ideas and inventions, the laugh would be on the other side.

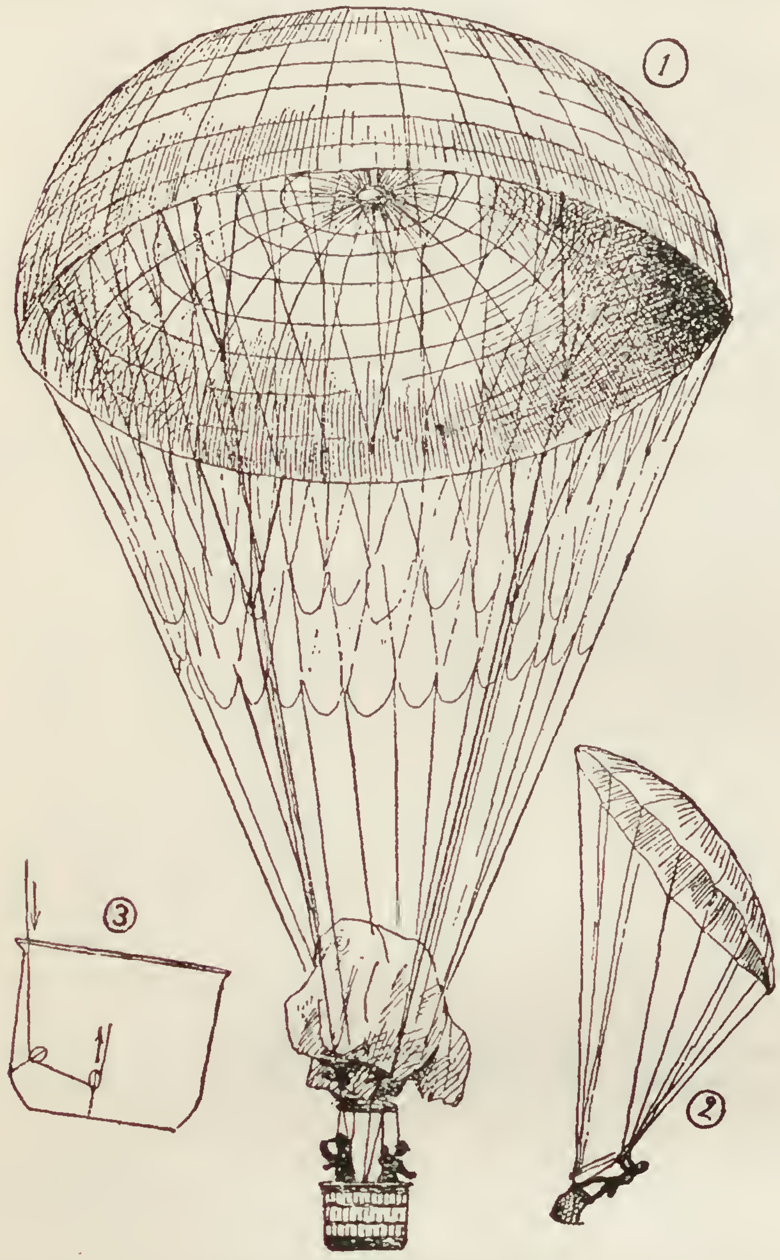
Charles Zimmerman, M.D.

Frederick, Md., May 3, 1895.

A GUIDABLE PARACHUTE.

Mr. Copazza, a French aeronaut, has for the past year been experimenting with a new dirigible parachute of his invention. This is placed above the balloon, the latter being so shaped as to be enclosed by the suspending lines which connect the parachute with the car. Upon attaining the desired height the balloon is torn open and collapsed, the envelope

falling down to the hoop, as shown on the engraving (fig. 1), and the expanded parachute then coming into action. A rope is attached to each of the two extremities of two rectangular diameters, by three different smaller lines, thus giving command (by passing each main rope round two pulleys fixed, as shown in fig. 3) of four rectangular directions, by drawing on the corresponding line and thus shifting the centre of gravity. This is considered an improvement upon the current practice of some aeronauts who climb on the edge of



A GUIDABLE PARACHUTE.

their car, as shown on fig. 2, in order to send their apparatus sideways to clear an obstruction.

Mr. Copazza has made some experiments by collapsing his balloon at a height of about 3,000 ft., and has descended in safety with a moderate success in directing his course. He is to experiment again this summer.

THE UNITED STATES SENATE ON AERIAL NAVIGATION.

On December 20, 1893, Senator Cockrell introduced a bill in the Senate of the United States providing

"That the Secretary of the Treasury is hereby authorized and directed to pay the sum of one hundred thousand dollars to any inventor, from whatever part of the world, who shall, at any time prior to the first day of January, A.D. nineteen hundred, construct a vessel that will, on the verified report of three engineers appointed by the Secretary of War, demonstrate, within or near the city of Washington, the practicability of safely navigating the air at a speed of not less than thirty miles an hour, and capable of carrying passengers and freight weighing a total of at least five tons."

Somewhat similar bills have been introduced in Congress before, generally in the interest of some inventor who thought that he had solved the problem of aerial navigation and wanted a chance of demonstrating it, but they have heretofore been laughed down or ignored. The remarkable thing about this last bill is that it was soberly considered, and that a special report thereon was made February 25, 1895, by the Committee on Interstate Commerce, through its chairman, Senator Brice.

This report (No. 992, Calendar No. 1,063) consists of 13 printed pages, and reviews the "state of the art" as made known by recent improvements and publications. It draws the line between *aeronauts* who believe that success is to come through some form of balloon and *aviators* who believe that the successful apparatus must be heavier than the air, and somewhat like a large sailing bird with pinions extended, and it discusses the advance made in recent years with each class of apparatus.

After describing what has been accomplished by the French with balloons, the report quotes from the opening address of Mr. Chanute to the Conference on Aerial Navigation in Chicago in 1893, concerning the present status of navigable balloons, and also gives extracts from a letter to Mr. Gillilaud written in May, 1894, by Mr. Chanute, whose conclusion is that: "Should the proposed bill become a law, its conditions would probably be complied with, and possibly by more than one inventor. . . . Such a craft, however, would necessarily be frail, and liable to many accidents after the first trials had demonstrated its speed and carrying capacity. It would doubtless prove efficient for war purposes, where risks must be taken, but could not compete with other modes of transportation in time of peace."

Then follows a memorandum prepared by Captain W. A. Glassford, of the United States Signal Corps, who superintended the construction and equipment in France of the United States signal balloon *General Myer*, stating that such light as has emerged, notwithstanding the profound secrecy maintained about French war balloons, indicates that for 81 days out of 100 the conditions of wind in France will permit of the use of such balloons, and saying: "This, considering the taking advantage of the velocity of favoring winds, is equivalent to a speed of 28 miles an hour in calm air, and therefore nearly attains to a satisfaction of the speed requirements of the bill."

The report then discusses the recent advance in attempts at aviation. It describes the gliding flights of Lilienthal, quotes from the writings of Professor Langley, Mr. Maxim, Mr. I. P. Holland, Mr. Eddy, Mr. C. W. Hastings, and Mr. J. B. Walker, and gives an account of the flight of Mr. Maxim's apparatus in England on July 31, 1894.

The Committee's final conclusion is:

"Owing, however, to the recent and still continuing deficiency in revenues to meet ordinary appropriations, and the condition of the Treasury, as shown by the several recent issues of United States bonds, your committee do not at present recommend the passage of this bill, but report the same without recommendation."

This report, although somewhat inconclusive, marks a new era in the public appreciation of the subject. It removes aerial navigation from the domain of vagary and recognizes that we are now within a measurable distance of success. It seems probable therefrom that the wise thing for the United States Government to do is to experiment with navigable war balloons, as the English, French, German, Russian, Austrian, Italian, Spanish, Belgian, and Holland governments have done, and to await some important advance in securing safety with aviating machines before undertaking to avail of the higher speeds to be expected with this class of apparatus.

Transit in Air.—Those who have written or experimented on the subject of aerial flight speak of a difference of effect with the wind and against it, and assume that power is lost in one case and gained in the other. Of course, if any form of flying machine is raised against the wind, at the first moment of starting it is impelled with a force equal to the velocity of the wind; but this is only a momentary effect due to the inertia from the weight of the machine, which soon becomes exhausted, and then the machine must finally partake of the velocity of the wind itself.

So prevalent has been this misunderstanding, that it has been asserted that a bird may acquire velocity by first going with the wind, and, with some velocity and momentum thus acquired, turn suddenly against it, and so gain an almost continuous raising power. But the fact is, the velocity in the tidal body of air is the same in all directions, and the force required for flight similar. A bird may be using up its utmost strength to fly at the rate of 40 miles per hour against a 40-mile breeze, and so appear to be stationary to observers on the earth below; but if the bird flies in the opposite direction, it will speed at the rate of 80 miles per hour relative to the earth, but the actual force and speed of flight *through the air* will be the same in both cases.

If the flying machine be launched from a balloon with the earth hidden from view by intervening clouds, there would be no means of ascertaining which way the wind was blowing relative to the earth, for a balloon is a perfectly stationary

machine floating in a body of air, and the flying machine, uninfluenced by the earth, might go off in any direction under precisely equal conditions, its real rate of progress being through the air only, and not to be measured by any reference to the earth below, of the existence of which the aeronaut may be as unconscious as if blindfold. It is like a ship that may be carried many miles out of her course by an ocean current, and of which the navigators may have been quite ignorant till their true position is detected by celestial observation.—*F. H. Wenham, in the English Mechanics.*

The Motion of Clouds.—In a recent number *Science* gives an abstract of a lecture on this subject delivered by Mr. W. N. Shaw, F.R.S., before the Royal Meteorological Society of London, on The Motion of Clouds Considered with Reference to their Mode of Formation.

The question proposed for consideration was how far the apparent motion of a cloud was a satisfactory indication of the motion of the air in which the cloud is formed. The mountain cloud cap was cited as an instance of a stationary cloud formed in air moving sometimes with great rapidity; ground fog, thunder clouds and cumulus clouds were also referred to in this connection. The two causes of formation of cloud were next considered—viz. (1) the mixing of masses of air at different temperatures, and (2) the dynamical cooling of air by the reduction of its pressure without supplying heat from the outside. The two methods of formation were illustrated by experiments.

A sketch of the supposed motion of air near the centre of a cyclone showed the probability of the clouds formed by the mixing of air being carried along with the air after they formed, while when cloud is being formed by expansion circumstances connected with the formation of drops of water on the nuclei to be found in the air, and the maintenance of the particles in a state of suspension, make it probable that the apparent motion of such a cloud is a bad indication of the motion of the air. After describing some special cases, Mr. Shaw referred to the meteorological effects of the thermal disturbance which must be introduced by the condensation of water vapor, and he attributed the atmospheric disturbances accompanying tropical rains to this cause. The difference in the character of nuclei for the deposit of water drops was also pointed out and illustrated by the exhibition of colored halos formed under special conditions when the drops were sufficiently uniform in size.

A HELIOGRAPH MESSAGE FROM BRITISH COLUMBIA TO MEXICO.

A copy of the following circular has been received by us, which will explain itself:

Portland, Oregon.

To the Editor of Aeronautics:

"Mazamas" is the name of a society of mountain climbers. It was organized on the summit of Mount Hood, Ore., on July 19, 1894, at which time and place the constitution and by-laws were adopted and first officers elected. Its organization was unique and successful. The experience of its members on that occasion inspires them to further achievements. The mountains furnish delight and inspiration which no man or woman can know or dream save those who have attained "exaltation" on the heights. There's health, joy and freedom there.

This year their aspiration is to convey by means of heliographs along the line of snow-capped peaks a sunbeam message from British Columbia to Mexico. Washington, Oregon, and California are invited to co-operate and carry out this plan.

The principal mountains in Oregon and Washington available for the purpose, beginning at the north, are: Baker, Rainier, St. Helens, Adams, Hood, Jefferson, Three Sisters, Diamond Peak, Thielsen, Scott and Pitt, and in California Mounts Shasta, Tellac, Round-Top, Dana, Lyell, Stillman, Whitney, Lowe, Baldy, and such other peaks as are necessary to complete the chain.

Citizens residing in the vicinity of the various mountains available for the purposes above suggested are besought to "take a hand" and aid the attempt. Arrangements can be made so that parties on sub-peaks, or in the valleys and towns along the line can communicate with those on their main mountains, and each group of mountaineers can, from their several signal stations, "telegraph," by flashes, to their neighbors below the fact of their presence on the peaks, and also the fact that the "message" from British Columbia is on its way and of the transmission of the answer from Mexico.

The intention is to send a message from British Columbia to Mexico and transmit an answer from Mexico to British Columbia, and as each message passes a signal peak, such signal peak is to report the fact to all such sub-stations, and groups in valleys and towns in their vicinity, as are prepared to receive it.

Storms may obscure some main peaks, so numerous side stations, or sub-peaks, are desirable to secure transmission of the through message.

The instrument to be used is the modern heliograph, such as is in use in the regular army, operating the "Morse Code."

Heliograph instruments can be obtained or prepared at comparatively small expense. The secretary will, on application, furnish addresses of regular manufacturers, and information for making suitable instruments sufficient for the purpose.

The date fixed for this event is July 10, 1895.

The main body of Mazamas as a society will assemble at Mount Adams in the State of Washington.

Correspondence is being opened and desired with all outing clubs, athletic, mountain, military, university and scientific organizations on the coast.

The Government officers and various State military organizations and officers are invited to arrange details from the signal corps "to aid the grand design."

Each party is requested to arrange for procuring photographic views of their several "camps" and principal points of interest, particularly of the group of climbers on the peaks attained.

Correspondence is solicited, and information will be supplied by the society.

W. G. Steel, *President*,
Miss May Fuller, *Vice-President*,
L. L. Hawkins, *Treasurer*,
M. W. Gorman,
Rev. Roland D. Grant,
J. Francis Drake,
} *Executive Council.*

Address all communications to

T. Brook White,
Secretary,

14 Worcester Block.

RECENT AERONAUTICAL PUBLICATIONS.

Gaston Tissandier the Balloonist. R. H. Sherard. *McClure's Magazine*, May, 1895. An interesting account of Mr. Tissandier's aeronautical work and opinions as to the future.

Wind Pressures in Engineering Construction. W. H. Bixby. *Engineering News*, March 14, 1895. An exhaustive review of publications and experiments on wind pressures and formulæ, and their application to structures.

Aerial Mechanical Flight. C. H. Mitchell. *Engineering Society of School of Practical Science. Toronto University*, February 20, 1895. A paper reviewing recent publications on aeronautical subjects, and formulating some of the principles which have been established.

Report on Aerial Navigation. Senator Brice. *United States Senate Publication*, February 25, 1895. The Committee on Interstate Commerce reports, without recommendation, on a bill (§ 1,344) which proposed to offer a prize of $100,000 for a navigable air-ship, and reviews the recent advances toward a solution of the problem.

Recent Experiments on Wind Pressures. J. Irminger. *Engineering News*, February 14, 1895.

Mr. O. J. Marstrand gives an abstract of the experiments of Mr. Irminger, of Denmark, concerning the pressure and rarefaction of air currents on different sides of plates and bodies inclined at various angles. It is shown that at small angles of incidence—0° to 5°—the wind blowing over a surface produces nothing but suction; this action throwing additional light upon the phenomenon of "aspiration."

Le Siège de Paris, vu à Vol d'oiseau. W. de Fonvielle. J. Hetzel & Co., publishers, Paris. 285 pp. Mr. de Fonvielle, the veteran aeronaut and author, has published a further account of the balloon ascents and journeys which took place during the siege of Paris in 1870. The book abounds with personal reminiscences, and incidentally throws a good deal of light upon the state of mind of the Parisians during this memorable siege. The author confines himself to relating the phases of some of the voyages, having already treated the technical part of the subject in his "Manuel pratique de l'Aéronaute."

AMERICAN ENGINEER AND RAILROAD JOURNAL.

Formerly the RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

The American Railroad Journal, founded in 1832, *was consolidated with Van Nostrand's Engineering Magazine,* 1887, *forming the Railroad and Engineering Journal, the name of which was changed to the American Engineer and Railroad Journal, January,* 1893.

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NEW YORK, JULY, 1895.

EDITORIAL NOTES.

THE usual discussion regarding the interchange rules was *the* discussion at the Master Car-builders' Convention, to the almost total exclusion of the other topics. As was to be expected, the Chicago agreement came in for its full share of attention, but its adoption was wisely postponed for serious consideration for another year. As we have already noted, the present rules seem to be crippled by their own weight and the almost utter impossibility of securing a uniform interpretation. Still they are working, and all hands are more or less familiar with them, so that it would not be advisable to step in with an innovation that would upset the existing order until that innovation has been more thoroughly tested than has been possible during the few months that the Chicago agreement has been in force. By another year the parties in favor of and opposed to the agreement will have been able to martial their forces, and we may look for some warm work when the subject is again thrown open for discussion.

THERE was some opposition to increasing the weight of cars at the Master Car-builders' Convention, on the ground of the great extra expense entailed in hauling. This was placed at one-half a cent per ton mile; so that, if one ton were added to each of five cars composing a train running 200 miles a day, the cost for extra haulage would be $5 a day, or approximately $1800 a year. The inaccuracy of this is so manifest that it seems strange that it was not detected on the spot. The one-half cent covers *all* expenses, and in this connection might be considered as fixed charges, while the extra cost of hauling is limited to the extra amount of coal burned, oil used, and wear, the latter being so small that it can be neglected. Taking the coal at 2½ oz. per ton mile, 156.25 lbs. represents the extra coal consumption per day, which, with coal at $2 a ton, would cost a trifle less than 16 cents, or about $48 a year. Fifty dollars would, on this basis, cover all *extra* expenses, provided, of course, that the existing engines would not have to be enlarged in order to haul this extra five tons.

CONVENTIONS.

FOR some reasons, which it is now not worth while to analyze, June has been selected as the season for holding engineering conventions. This year the Master Car-builders' Association led off on June 11 at Thousand Islands, and was followed a week later by the Master Mechanics at the same place. The Civil Engineers also met at that time in the Hotel Pemberton in Boston Harbor. The Mechanical Engineers assembled in Detroit on June 25, and the International Railway Congress met in London on June 26.

A very common inquiry by persons who are not familiar with the objects and proceedings of these meetings is, What are they for? A question which is answered by different people in different ways. Some persons who are not much interested in technical subjects would say that their object is that the members and others who attend them may have an outing and a good time; others would say that their chief purpose is to afford an opportunity to those who attend them for social intercourse. The Constitution of the Master Car-builders' Association says:

> "The objects of this Association shall be the advancement of knowledge concerning the construction, repair, and service of railroad cars, by discussions in common, investigations and reports of the experience of its members; to provide an organization through which the members and the companies they represent may agree upon such joint action as may be required to bring about uniformity and interchangeability on the parts of railroad cars, to improve their construction and to adjust the mutual interests growing out of their interchange and repair."

The Constitution of the Master Mechanics' Association has substantially the same provision and statement of objects.

The objects of the Society of Civil Engineers is defined to be:

> "The advancement of engineering knowledge and practice and the maintenance of a high professional standard among its members.
>
> "Among the means to be employed for this purpose shall be meetings for the presentation and discussion of appropriate papers and for social and professional intercourse."

What the Mechanical Engineers' Society aims to accomplish is, as formulated in its "Rules:"

> "To promote the Arts and Sciences connected with Engineering and Mechanical Construction by means of meetings for social intercourse and the reading and discussion of professional papers."

In seeking to accomplish these avowed objects, each of these associations holds at least one annual meeting, which is attended by from 500 to 1,000 people, who devote from one to ten days' time thereto. The average expenses for attendance of members in all probability is not less than $50, and the cost for printing, reporting, and other expenses incidental to the holding of the meetings will amount to fully $5,000 apiece, so that the actual cost in money of holding each of these meetings must be somewhere from $30,000 to $55,000. If, in addition to these amounts, we charge $10 per day as the average value of the time of those in attendance, this cost would be more than doubled. With that of entertainments of various kinds, it will probably be quite within reasonable limits to say that the annual expense of holding the four meetings referred to must be somewhere from $500,000 to $1,000,000. The London meeting will be much more costly than any of the American assemblages on account of the larger number of people who will be in attendance, the greater distance they must travel, and the time consumed to attend it.

It is, therefore, worth considering whether this large expenditure of money is as productive of the results aimed at as it could be made, or, in other words, it may be asked whether

we are getting the full worth of the expenditure ; and if not what should be done to increase the usefulness and the profit of such organizations ?

The problem may be stated somewhat as follows : Several hundreds of people engaged in kindred engineering occupations come together annually for deliberation on subjects in which they are mutually interested, and with reference to which each one has had experience and knowledge of his own which differs more or less from that of all the others. *Problem :* How to extract the maximum amount of information from those who have it for the benefit of those who have it not.

The solution will require some investigation into the philosophy and practice of deliberative or, as Jefferson called them, "considerative" bodies.

Now, what is a deliberative body and what is it organized for ? "Deliberation," the dictionary tells us, is "the act of weighing or examining, or the careful discussion of the reasons for and against a choice or measure." A deliberative body is based on the fact that all people see things differently. Dr. Holmes said that it was a mistake to assume that there were only two sides to every question, and observed that all subjects were at least hexagonal. We are all too apt to feel and assume that our view of any matter is the only one which any person can rationally have. Experience teaches us that there is an infinity of ways of regarding all topics which are presented to the human consciousness ; and if we are wise we learn that much practical wisdom can be elicited by the free presentation, comparison, and discussion of varying opposing and divergent views, theories, facts and measures. The prime intent and aim of a deliberative body, therefore, is that it should be a *talking* body ; and, as Carlyle said, "Speech is the gaseous element out of which most kinds of practice and performance . . . condense themselves and take shape ; *as the one is, so will the other be.*" In view of the time, thought and money which are annually devoted to the meetings under consideration, if it be true, as Carlyle indicated, that as the talk at these meeting is, so will be the subsequent practice and performance of those who attend them, it is of very great importance that the very best talk should be obtained that is possible. It must be kept in mind that the fountains of talk, the sources of knowledge and wisdom which supply the stream that flows from these meetings, are in the minds of the members who compose the associations. The members must be taken as they are, with their training, experience and education (or lack of them). If all of them could have had the advantages of a liberal education, or if it were possible to unscrew some of their heads and readjust the impalpable mechanism of their brains, so as to quicken their powers of observation, correct the lenses of their minds through which they see things strabismatically, readjust the gearing of their logical mills so that they would grind out only reasonable inferences and conclusions, doubtless their deliberations would be immensely improved. Unfortunately our heads are not removable excepting with disastrous results, and when the bearings of our minds become worn we can't put in new "brasses," and it is difficult even to lubricate them if they once get hot. All that can be done is to get the best we can out of the members of the associations as they are.

They meet together for the ostensible purpose of advancing or increasing knowledge of the subjects in which they are all interested. Varying degrees and kinds of knowledge is dispersed among these individuals, is unequally diffused among them on account of the infinitely varied causes which have influenced their intellectual development. The problem, then, evidently is to collect from all those who meet together the most valuable knowledge of which they are each possessed and weigh it or subject it to a kind of intellectual assay to determine its value. In other words, it is required to extract from a somewhat miscellaneous lot of ore the grains and the lumps of pure metal which it may contain. To carry our analogy a little farther, each member of these conventions, it may be supposed, brings his "kibble" of intellectual ore to the meeting, and the purpose should be to extract as much precious metal therefrom as possible. Now, how can this be done ?

It has been said that the object of a deliberative body is to call out and *hear* talk. The word hear is italicized in order to call attention to its literal meaning, for the reason that after an experience of 25 years in attending conventions it has been observed that at most of them it has not been possible to *hear*. This has been due to bad acoustic properties of the rooms in which the meetings were held, the bad arrangement of the seats in relation to the chairman and his satellites, and to outside noises and disturbances. The members travel hundreds—some of them thousands—of miles and devote days or weeks of time and expend considerable money in order to talk for perhaps a few minutes and to listen for many hours, and when they reach their destination they find that the main purpose for which they have come has been to a very considerable extent defeated by one or more or all of the causes enumerated. The cure for these evils is, first, care in the selection of a hall. This should not be too large, as there are seldom more than 250 persons present at any of the meetings. Second, there should be a committee appointed to take charge of the meetings, part of whose duty should be to see that all disturbing noises, both within and without the meeting-room, are suppressed. The chairman's platform and the seats should be arranged in such a way that the former would occupy a central position in relation to the latter, and so that the seats should face the chairman in front and on each side of him. If this had been done in the "opera house" at Alexandria Bay it would have enabled many of those present to hear, who, as it was, could get only a confused idea of what was going on. This feature of the meetings is worthy of attention too, because hearing has a reflex action on the mind and stimulates those who hear well to speak, whereas if the listeners get only a vague and confused idea of the proceedings their mental energy is consumed by the effort to hear, and they have not enough left to stimulate them to talk. It can constantly be seen that, owing to inability to hear, members grow tired and leave the meeting-room, and the "proceedings interest them no more." If the usefulness of a convention under the most favorable circumstances is represented by 100, that usefulness would be diminished at least 33⅓ per cent. if the members cannot hear what is going on.

But some one has said, "There are many who talk on from ignorance rather than from knowledge, and who find the former an inexhaustible fund of conversation." This is true, probably, of all deliberative bodies. The wind-bag we have always with us. He is irrepressible. All that we can hope to do is to reduce his dimensions as much as possible ; but inasmuch as he is gaseous by nature, he will always expand and fill any space he is permitted to occupy. Our only hope is to limit his time. There is a beneficence about the laws of human thought and expression which affords a sort of refuge from ignorance and fatuity. It is the fact that wisdom and knowledge can generally be expressed briefly, whereas the length and depth and breadth of folly or *nescience* requires much time to unwind itself. The obvious thing to do, then, is to limit the time of speakers. If this is done, those who have anything which is much worth hearing will generally be able to say it, while the fountains of folly will be shut off. The difficulty generally is to find a chairman who is sufficiently ruthless to enforce the time limit rigidly. To meet this difficulty, some one has proposed a mechanism for the protection of deliberative bodies from blatherskites. It was to consist of a small platform on which each speaker must stand when he addresses his audience. Over this platform a pail of water is to be suspended on trunnions. Clock-work is connected with the pail

and the platform, so that when the speaker steps on the latter it will wind up the horological mechanism so as to run just five or 10 minutes, and then—tip the pail.

No intellectual sieve has ever been devised for a deliberative body which will let the wind-bags through, and will retain only those speakers who are most worth listening to. It would be an unspeakable blessing if some such discovery could be made. Until such an invention is perfected, reliance must be placed on the chairman of the meetings. Much depends upon him. If he has the discrimination to know who are the men best worth listening to, he can do much to encourage them to speak and to call them out at the proper times.

Most of our readers are familiar with the system of appointing committees of investigation to report on various subjects of interest to the two railroad associations referred to in the beginning of this article. The same system has been adopted by the International Railway Congress. A common complaint which has been made is that the circulars of inquiry which are sent out by committees are answered by comparatively few persons to whom they are sent. This fact and the other consideration that printed or written questions are very much less effective in educing information than oral inquiries are, leads to the suggestion that committees of investigation of the various associations might with advantage call such members as are supposed to have some special or valuable knowledge relating to the subjects of investigation to appear before them during the sessions of the conventions, to give testimony and be questioned in relation to such subjects. The advantages of oral and cross examinations are shown daily in our courts of justice. Of course the appearance before such committees and the answering of questions would only be voluntary, as the associations have no authority to compel any one to appear or to answer. If, for example, a committee on water-tube boilers should invite persons who have been using such boilers to appear before them, while the convention was in session—or at other times—and should question them with reference to the performance, defects and advantages of such boilers, it would be quite sure to result in the collection of a great deal of very valuable information which probably could not be obtained otherwise. Of course the party appearing could decline to answer any inquiries he might not want to answer. If a committee on compound locomotives could have invited a dozen members of the Master Mechanics' Association to appear before them, and could, by skilful questioning, have elicited from them the results of their experience during the past few years, it would have enabled such a committee to get information which it is next to impossible to get otherwise, and which it is utterly hopeless to expect will come in response to a printed circular of inquiry. With this privilege a committee could select the men to appear before them who are known to have the information desired, the intelligence to discern that which is important from that which is not, and who would be sufficiently independent to give their testimony without fear or favor.

Some months ago we commented on the summary manner in which discussions were often ended in these associations by persons who are not interested in the subject moving—just as the audience was warming up to the debate—that the discussion be closed. The matter was referred to by Mr. Lentz, the President of the Master Car-builders' Association, in his annual address, in which he said :

"In order that there may be a full discussion on all questions that may be brought before the convention, I propose and ask for your consent to depart from the usual custom of parliamentary practice to this extent ; when a motion is made to close the discussion, I ask the privilege of ascertaining for the information of the members if any one still wishes to talk further on the subject, and I would recommend an amendment to the by-laws providing for this change in practice."

Such an amendment, we learn, was adopted, and this particular form of gag is not likely to be applied to discussions in this association hereafter.

There is one other topic that ought to be referred to before this long article is ended—that is, the importance of brevity in the proceedings of our associations. There are now so many of them, and they are turning out such quantities of "proceedings" that it is impossible for busy men to do more than skim over it. Our plea is, give us the best of everything, but let it be short as possible.

TWO NOTABLE LOCOMOTIVES.

In the last number of the American Engineer we gave illustrations and a description of a locomotive built at the Baldwin Locomotive Works for the Concord & Montreal Railroad. In this number we give similar illustrations of another engine for the same kind of traffic and for the same road, but built by the Schenectady Locomotive Works. The one illustrated last month, it will be remembered, was a 10-wheeled engine of a design which has not yet been extensively introduced into this country, but of a type which is common on the continent of Europe. The Schenectady engine, on the other hand, is of the ordinary American type, with four driving-wheels and a four-wheeled truck. As these engines are for the same line and to be used in the same traffic, a comparison of their performance and merits will be possible and will be interesting. Both of these machines are admirable specimens of the art of locomotive-building, and their performance will be watched with much interest. To facilitate comparison, the weight and dimensions of each are printed in parallel columns.

The writer confesses to a predilection for a design of locomotive similar to that which the Baldwin Works have adopted. A concession, however, had to be made by them to the impression that a four-wheeled leading truck is essential for safety in a high-speed engine. This makes it difficult to get all the advantages which would result from this general plan if it was somewhat modified. It will be remembered that the *Columbia*, which the Baldwin Company exhibited at Chicago, had a leading truck with a single pair of wheels in front. With this arrangement and by moving the driving-wheels about a foot farther forward, the fire-box would be entirely behind the back pair. If a pair of trailing wheels of 36 in. in diameter were substituted instead of the 50 in. wheels which were used, the fire-box could then be made as wide as might be desired, and therefore shorter than it was in the engine for the Concord road.

We have quoted a number of times in these pages a paper written about two or more years ago by Frederick Siemens, in which he showed that whenever flame came in contact with any solid substance combustion was partially arrested, and that in all furnaces we should aim to keep the flame out of contact with their sides until the process of combustion is completed. The inference from this was that a sphere would be the ideal form for a furnace, and in fact that is approximately the shape adopted in the ordinary egg-shaped stoves for burning bituminous coal. But as a sphere would not be a convenient form for a locomotive fire-box, and as a cube is the closest approximation thereto that existing shapes will admit of, the inference is that it might be well to make locomotive furnaces of such dimensions that their height, length and breadth would all be equal. This would be possible with a locomotive of a design similar to the *Columbia*, and it is believed would make a very efficient engine. The plan permits the driving-wheels to be placed as close together as the flanges of their wheels will allow. The coupling-rods may therefore be correspondingly shortened. These wheels being under the middle of the engine, they can be loaded with as much or as little weight as may be desired, and a liberal length of tube would be provided.

The performance of these two engines will be watched with a great deal of interest, and we will endeavor to keep our readers informed of what they are doing. They are each excellent examples of the latest American practice.

NEW PUBLICATIONS.

THE MECHANICAL ENGINEER'S POCKET-BOOK. *A Reference Book of Rules, Tables, Data and Formulæ, for the Use of Engineers, Mechanics and Students.* By William Kent. New York: John Wiley & Sons. 1087 pp., 4 × 6½ in., $5.00.

Current engineering literature is beginning to fill the minds of many engineers with dismay. Thirty or forty years ago, when many of us started in our careers, an assiduous student could hope to acquire an intimate acquaintance with all the valuable books relating at least to any one branch of engineering. Now this is no longer possible, and the attention of students must be confined to some special branch, and these branches are narrowing more and more each year. Fifty years ago the chief engineer of a railroad was expected to—and did—design all the structures, rolling stock, and machinery on a railroad. Now, not only are the bridges, locomotives, cars and shop machinery all designed and built in separate establishments, but the various parts, even to such minute details as the split keys used to secure nuts on bolts, are made by firms who do little else. It seems, therefore, that the engineer of the future will be a person who will know all that can be known about some detail like split keys, and who need not know anything else. The "profession" of engineering—as our civil engineering brethren love to call their occupation—may in the future be likened to a honeycomb—that is, it will consist of many cells, each filled with a store of knowledge deposited there by the busy bees who occupy the hives of industry and learning. Following out the simile, the book before us may be likened to the bees' comb, which is divided into a great number of cells, and in which information, gathered from a vast number of sources, has been deposited, and classified and placed within the reach of those who are mentally a-hungered.

Mr. Kent's book may be described as a cross or halfway station between Molesworth's "Pocket-Book of Engineering Formulæ" and Linehan's "Text-Book of Mechanical Engineering," which was reviewed in our February number. The former very useful book gives only formulæ, rules, tables, data, etc., while Mr. Kent's gives more or less explanation of the different subjects referred to. These explanations assume the form of dissertations and short essays, which are often taken from technical papers, books, etc., and give an epitome of the "state of the art." Thus the introduction to the section relating to the Strength of Materials consists of a short essay from which the reader can get a better idea of the general subject than he could obtain, perhaps, from any other source. The same observation would apply to many other postures of the book.

In the table of contents the subjects are classed into general divisions, which are subdivided under heads and subheads. There is only room here for the first and second, the general divisions being printed below in capitals, and their subdivisions in small type. These include:

MATHEMATICS.—Arithmetic; Weights and Measures; Algebra; Mensuration, Plane Surfaces; Mensuration, Solid Bodies; Plane Trigonometry; Analytical Geometry; Differential Calculus; Mathematical Tables.

MATERIALS.—Miscellaneous Materials; Strength of Materials; Alloys; Ropes and Chains; Springs; Riveted Joints; Iron and Steel; Steel.

MECHANICS.—Elements of Machines; Stresses in Framed Structures.

HEAT.

PHYSICAL PROPERTIES OF GASES.

AIR.—Flow of Air; Wind; Compressed Air; Fans and Blowers.

HEATING AND VENTILATION.

WATER.—Hydraulics; Flow of Water; Water-power; Turbine Wheels; Pumps; Hydraulic Pressure Transmission.

FUEL.—Petroleum; Fuel Gas; Illuminating Gas.

STEAM.—Flow of Steam; Steam Pipes.

THE STEAM BOILER.—Strength of Steam Boilers; Boiler Attachments, Furnaces, etc.; Safety Valves; the Injector; Feed-water Heaters; Steam Separators; Determination of Moisture in Steam; Chimneys.

THE STEAM ENGINE.—Compound Engines; Steam Engine Economy; Rotary Steam Engines; Dimensions of Parts of Engines; Fly-wheels; the Slide Valve; Governors; Condensers, Air Pumps, Circulating Pumps, etc.

GAS, PETROLEUM AND HOT-AIR ENGINES.

LOCOMOTIVES.

SHAFTING.

PULLEYS.

BELTING.

GEARING.—Forms of the Teeth; Strength of Gear Teeth.

HOISTING.—Cranes; Wire Rope Haulage.

WIRE-ROPE TRANSMISSION.

ROPE DRIVING.

FRICTION AND LUBRICATION.

THE FOUNDRY.

THE MACHINE SHOP.—Abrasive Processes; Various Tools and Processes.

DYNAMOMETERS.

ICE-MAKING OR REFRIGERATING MACHINES.—Actual Performance of Refrigerating Machines; Artificial Ice Manufacture.

MARINE ENGINEERING.—The Screw Propeller; the Paddle-wheel; Jet Propulsion; Recent Practice in Marine Engines.

CONSTRUCTION OF BUILDINGS.

ELECTRICAL ENGINEERING.—Standards of Measurement; Electrical Resistance; Electrical Currents; Electric Transmission; Electric Railways; Electric Lighting; Electric Welding; Electric Heaters; Electric Accumulators or Storage Batteries; Electro Magnets; Dynamo Electric Machines.

This list will indicate that there are many subjects treated of in this new book which are not referred to in the older pocket-books. In fact, the information relating to all the subjects referred to in the book is brought up nearer to recent knowledge and practice than that in any similar book which has preceded it. This, it is true, might be expected; but when it is seen what an immense amount of labor was involved in doing this, what vast fields of literature had to be gone over to summarize what is given in such a small space, the amount of work which has been done by the author can be even then but faintly realized, and is a monument to the author's industry and ability.

The book is admirably printed on excellent thin paper, and is bound so that it opens easily and agreeably, and in that respect is in marked contrast with many recent books which require to be pried open in order to make the inner margins of the pages visible. Its dimensions, notwithstanding the large number of pages, are such that it can be carried in a not very capacious pocket.

It should be added that the book is intended especially for mechanical engineers, the field of which, the author says, "was considered so great and the literature of the subject so vast that as little space as possible should be given to subjects which especially belong to civil engineering. The latter branch," it is said further, "is so well covered by Trautwine's 'Civil Engineers' Pocket-Book,' that any attempt to treat it exhaustively would not only fill no 'long-felt want,' but would occupy space which should be given to mechanical engineering."

The book can by highly commended, and a debt of gratitude is due to the author from his brethren for giving them this new and effective instrumentality, which will be a valuable assistant in their daily work.

THE ELECTRICAL JOURNAL, an Illustrated Newspaper Devoted to the Interests of Electrical Progress and Education. Vol. I, No. 1. 20 pp. of reading matter; xvi of advertisements; 9¼ × 12¼ in. The Electrical Journal Publishing Company, Chicago. J. P. Barrett, President. Published semi-monthly.

It is a journalistic obligation to welcome all new-comers, although there are far too many of us cumbering the ground already. The stranger which has just been born is a comely infant, well printed and papered, and fairly well illustrated. Its "aim" in a "salutatory," it is said, will be to keep the very large class of people in this country who are interested in electricity—commercially or otherwise—the members of which are practically debarred from a knowledge of electrical principles and laws owing to the deeply scientific and mathematical character of existing text-books and current literature, posted on electrical matters, and to present for their information and entertainment items and discurses on every conceivable subject." It is a wide field to undertake to occupy, but one which, if well cultivated, let us hope will bring forth a plenteous harvest.

NOTES ON RANKINE'S CIVIL ENGINEERING. By David C. Humphreys, Professor of Applied Mathematics in Washington and Lee University. For sale by the Author, Lexington, Va., and by Charles Scribner's Sons, New York. Price, $4.

These notes, which are in lithographed, round writing, and occupy 184 large quarto pages, are an extension of those published in 1873 by Professor William Allen, of Washington and Lee University. It thus appears that the works of Rankine have been used in this institution for a period of twenty years

or more. Twenty or thirty years ago Rankine's text-books were almost the only ones giving advanced theoretical discussions of mechanical principles directly available for technical schools. To-day, however, they are but little used on account of their obscurities and the fact that numerous other text-books on modern lines of thought can be had. Rankine was a master of theoretical mechanics, but he wrote in the days when it was considered proper to present the subject in an obscure and difficult form. The simple question of stresses in trusses, for example, is overloaded with complex formulas, so that a student, even with the assistance of these notes, can gain but an imperfect knowledge of the methods used in practice. Very few numerical examples or problems illustrating the principles of statics can be found either in Rankine's civil engineering or in Professor Humphreys' notes. It may be that a student who has burned the midnight oil over formulas for the dead load stresses in the nth strut of a Warren girder has gained some mental discipline, but one who is taught to compute the stresses due to locomotive wheel-loads without any formulas at all certainly has a far better understanding of the principles of statics. Teachers of engineering will find these notes useful when they consult Rankine, for Professor Humphreys has done much to clear away many difficulties, and the list of 69 errors that he has discovered in the text shows that even the formulas of a master must be used with great caution.

BOOKS RECEIVED.

Proceedings of New York Railroad Club. Meeting of May 16, 1895. Discussion on Tools for Locomotives and the Inspection of Steel-Tired Wheels.

Proceedings of the Western Railway Club. Chicago, April 16, 1895. New Constitution; Discussion on Train Staff System; on Strength of Car Axles; on Interchange Rules.

Proceedings of the New England Railroad Club. Boston, May 8, 1895. Electrical Apparatus in Connection with Signalling and Moving of Trains, papers by J. V. Young and J. P. Coleman.

Proceedings of the Fourth Annual Meeting of the American International Association of Railway Superintendents of Bridges and Buildings, October 16, 17, and 18, 1894. 104 pp., 6 × 9 in.

Proceedings of a National Convention of Railroad Commissioners, held at the office of the Interstate Commerce Commission, Washington, D. C., May 14, 1895. First Day's Proceedings. 37 pp., 5¾ × 9 in.

Proceedings of the Southern and Southwestern Railway Club. Atlanta, Ga., April 18, 1895. Discussion of the Code of Rules Governing the Condition of and Repairs to Freight Cars for the Interchange of Traffic.

Proceedings of the Central Railway Club. Buffalo, April 24, 1895. Discussion of the Report of the Committee on Revision of the Constitution and By-Laws; Report of the Committee on Revision of the Rules of Interchange.

Proceedings of Southern and Southwestern Railway Club. Meeting of April 18, 1895. Review of Master Car-Builders' Rules; Report of Committee, and discussion thereof; Uneven Wear of Driving-Wheel Tires; Report of Committee and discussion; Most Economical Method of Obtaining Compressed Air; Report of Committee and discussion; the Most Economical Tonnage Spring; Report of Committee and discussion.

American Society of Civil Engineers, March, 1895. Transactions, Vol. XXXIII, No. 3; Proceedings, Vol. XXI, No. 3. Paper on the Bridge over the Tennessee River at Johnsonville, Tenn., by Hunter McDonald, with discussion. Paper on Wind Bracing in High Buildings, by Guy B. Waite, with discussion. Paper on the Relative Effects of Frost and the Sulphate of Soda Efflorescence Tests of Building Stones, by Lea McI. Luquer. Minutes of Meetings.

Beeson's Inland Marine Directory. 302 pp., 6½ × 9½ in. Eighth Annual Edition. This useful publication contains lists of American and Canadian Lake and River Merchant Steam and Sailing Vessels, Owned and Operated on the Northwestern Lakes and Waters Tributary Thereto; and a variety of other data and information relating to marine matters on the lakes. It is compiled in its usual convenient form, and contains a liberal number of advertisements.

Proceedings of the Meeting of the American Railway Association, held at the Planters' Hotel, St. Louis, Mo., April 17 and 18, 1895. 103 pp., 7½ × 10¼ in.

The "Proceedings" at this meeting include Reports of the Executive Committee; on Arrangements for the International Railway Congress; on Standard Wheel and Track Gauges; on Train Rules, and a long discussion thereon; on Car Service; on Safety Appliances; on Location of Handholds and Grab Irons; on Interlocking and Block Signals, and a discussion thereon; Rules of Order of the Association; Address of the President, Mr. H. S. Haines; Schedule of the Proceedings of the International Railway Congress.

Engine and Boiler Room. Vol. I, No. 1. This is the first number of a new monthly engineering periodical which has just been launched in Chicago, and of which Mr. S. K. Monroe is Manager; T. P. Pemberton, Editor; and A. Bement, Associate Editor. Its size is 7 × 10 in., and contains 18 pages of reading matter. It is well printed and fairly well illustrated, but the price being only 50 cents per year, single copies 5 cents, perhaps the highest style of the illustrator's art could hardly be expected or demanded. It is always gracious to wish a newcomer good luck and prosperity. In the present instance the publishers have made an attractive paper, and whatever the measure of success, it seems the publishers and editors must certainly be credited with courage and temerity in putting afloat another journalistic bark on a sea which is now so much overcrowded.

TRADE CATALOGUES.

In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. The advantages of conforming to these sizes have been recognized, not only by railroad men, but outside of railroad circles, and many engineers make a practice of immediately consigning to the waste-basket all catalogues that do not come within a very narrow margin of these standard sizes They are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.

STANDARDS:

For postal-card circulars............	3¾ in. × 6½ in.
Pamphlets and trade catalogues......	3½ in. × 6 in. 6 in. × 9 in. 9 in. × 12 in.
Specifications and letter-paper........	8½ in. × 10¾ in.

The last number of the *Official Gazette* of the United States Patent Office contains the following notice:

"This office would be pleased to receive from manufacturers and publishers such catalogues, circulars, price-lists, or other advertisements relating to the sciences and mechanical arts as are published by them for gratuitous distribution; but notice is hereby given such manufacturers or dealers who feel disposed to send their publications that not less than three copies should be forwarded in order that the subjects may be properly indexed, classified, and sub-classified in the Scientific Library for convenient and ready reference."

Pencoyd Iron Works. Bridge and Construction Department. General Specifications for Railroad Bridges. A. & P. Roberts Company, Philadelphia. 20 pp., 6½ × 10 in. [Not standard size.]

Air or Gas Compressors Driven by Corliss Engines, Belt or Rope. Built by Philadelphia Engineering Works, Limited, Philadelphia. 4 pp., 6 × 9¼ in. [Not standard size.]

The title of this leaflet indicates its character. The compressor manufactured by this company is illustrated by very good wood-engravings—side view and plan—with a description and statement of its advantages accompanying it.

Combine Safety Water-Tube Boiler. L. M. Moyes, Manufacturer, Philadelphia, Pa. 8 pp., 6 × 9 in. [Standard

THE STEAMSHIP "ST. LOUIS," OF THE AMERICAN LINE, BUILT BY THE WILLIAM CRAMP & SONS SHIP AND ENGINE BUILDING COMPANY.

size] This little pamphlet sets forth the arguments in favor of the "combine" boiler illustrated in our last number, and is in part a reply or comment on "Facts" published by the Babcock & Wilcox Company. It is without illustrations, and gives merely the reasons for the superiority of this type of boiler.

SPEIDEL'S PATENT ECONOMIC SAFETY HOISTS. Speidel Brothers, Reading, Pa. 28 pp., $4\frac{5}{8} \times 7\frac{5}{8}$ in. [Not standard size.]

This Company makes portable hoists, overhead tramways, travelling cranes, portable derricks, stationary and cellar hoists, all of which are illustrated and described in the publication before us. The illustrations are good wood-cuts, and tables of sizes and capacities are given in convenient and attractive form.

STEAM PLANTS FOR DRIVING DYNAMOS IN ELECTRIC-LIGHT, RAILWAY, AND POWER STATIONS, AND ISOLATED PLANTS, ETC. The Pond Machinery Company, 709 Market Street, St. Louis, Mo. 17 pp., $3\frac{1}{2} \times 6$ in. [Not standard size.]

The purpose of this little publication is to give an advertisement of the business of the Pond Company and a statement of what they are prepared to do, and it also gives a long list of steam plants which the Company has furnished in whole or in part.

ECONOMY GUARANTEES OF ENGINES. The Westinghouse Machine Company, Pittsburgh, Pa. 12 pp , $3\frac{5}{8} \times 6$ in. [Not standard size.]

In this little pamphlet the Westinghouse Company announce that they will give an economy guarantee of the performance of their engines, and that purchasers can have their engines tested by their own experts at the Westinghouse shops before shipment if they so desire, and may accept or reject the engine on that test before incurring the expense of installation.

ELECTRIC ELEVATORS. Catalogue of Sulzer-Vogt Machine Company, Louisville, Ky. 20 pp., 6×9 in. [Standard size.]

In the "introductory" this company says that "electric elevators have long since ceased to be an experiment, and are now the most economical elevator, not only in cost of running, but in space occupied and convenience and ease of operation." They illustrate with good wood engravings the hoisting machines for freight and passenger elevators, various forms of platforms and elevator cars, and other appliances which are furnished, all of which are described.

THE WE-FU-GO PROCESS OF PURIFYING FEED-WATER FOR STEAM BOILERS, HEATERS, ETC. The We-Fu-Go Company, Cincinnati, O. 19 pp., $3\frac{1}{2} \times 6\frac{3}{8}$ in. [Not standard size.]

The fact that Mr. Fred. C. Weir is President and N. O. Goldsmith Vice-President of this Company would indicate that it is not composed of Chinamen, as its title would suggest. Their trade catalogue is a brief elementary treatise on incrustation. Little information is given with reference to the process with the barbaric name, excepting that "it precipitates the scale-forming impurities by converting them into an insoluble condition by the addition of chemical reagents."

ECONOMY WATER-TUBE BOILER. Economy Water-Tube Boiler Company, New York.

This Company have published a descriptive catalogue of their boiler, which is in the highest style of this class of literature. It is illustrated with admirable wood engravings of the boiler and its details. The descriptive matter explaining its construction and operation is also excellent, and will enable the reader to understand both without any other effort excepting that of reading the description attentively. The cover, especially, is an attractive one, and the publication as a whole should incline those who receive it to regard the boiler favorably.

RAILROAD EDITION. CATALOGUE AND PRICE-LIST OF MECHANICAL RUBBER GOODS. 62 pp , $3\frac{1}{2} \times 6$ in. [Standard size.]

ILLUSTRATED CATALOGUE AND PRICE-LIST OF RUBBER MATS, MATTING AND STEP TREADS. Boston Belting Company, Boston and New York. 14 pp., $3\frac{1}{2} \times 6$ in. [Standard size.]

The articles manufactured by this company which are used by railroad companies include belting, hose of various kinds, packing, gaskets, valves, tubing, rubber springs, diaphragms, rubber mallets, matting and flexible rubber hose-pipes, all of which are illustrated in the two pamphlets before us, which are well printed ; the engravings are good, and all but the binding can be commended. The latter is done with wire, and holds the leaves together and prevents them from being opened comfortably.

STANDARD EVAPORATION COMPUTER. Designed by William Cox. The Babcock & Wilcox Company.

This company have issued a very neat and convenient device for making calculations which are based on the formula

evaporation in pounds from and at 212° $= W\frac{H-h}{966}$, in which

W is the weight of water or steam in pounds at actual pressure and temperatures, H is the heat units in the steam, and h is the heat units in the feed-water per pound, and any calculation depending upon this formula may be made with it. It consists of a circular cardboard disk graduated, which revolves in contact with other segmental graduations and scales, the arrangement and purpose of which could not be explained so as to be intelligible without engravings. The whole is mounted in a neat morocco case in convenient form.

THE CAHALL VERTICAL WATER-TUBE BOILER. Manufactured by the Aultman & Taylor Company, Mansfield, O. Third Edition. 45 pp., $5\frac{1}{4} \times 7\frac{5}{8}$ in. [Not standard size.]

The "Cahall" boiler consists of an upper and lower drum, which are connected by 4-in. tubes. The products of combustion impinge against the tubes above the lower drum, and then pass around the tubes and escape through a central opening in the upper drum and thence to the chimney. The publication is illustrated by half-tone engravings representing a view of the works and different parts of the boiler, and some excellent wood-engravings representing sectional views of the boiler. A number of views made from "wash" drawings show external views of groups of boilers and their setting. The descriptive matter and reports of tests are all very clearly presented, and enable the reader to get a very good idea of the boiler and its merits.

THE OFFICIAL RAILWAY LIST, 1895. Fourteenth Annual Edition. Published by the Railway Purchasing Agent Company, Chicago. 422 pp., $4\frac{1}{2} \times 8\frac{1}{2}$ in.

The "List" comes to us again this year with more pages, more advertisements, and a general appearance of more prosperity. An extract from its copious title-page will describe the character of the book to those not acquainted with it. It is said there that it is "a complete directory of the presidents, vice-presidents, general managers and assistants, general and division superintendents, chief and assistant engineers, secretaries, treasurers, auditors, traffic managers, general freight agents, general passenger and ticket agents, baggage agents, superintendents of telegraph, purchasing agents, fuel agents, car accountants, superintendents of motive power, master mechanics, master car-builders, master car-painters, foremen of repairs, roadmasters, etc., of railways in North America, and handbook of useful information for railway men"—all of which it is, and more too.

THE WAINWRIGHT STEAM APPLIANCES. Made and sold by the Taunton Locomotive Manufacturing Company, Taunton, Mass. 64 pp., 8×10 in. [Not standard size.]

The "appliances" referred to in the title are feed-water heaters, surface condensers and expansion joints. The Wainwright feed-water heater consists of a cylindrical vessel with two tube-plates at some distance from its ends, and covers on the ends. Corrugated tubes extend from one tube-plate to the other, and are fastened to them in the usual way. The tubes communicate from the space between the tube-plate and head at one end to that in the other. The exhaust steam is admitted to the space between the two tube-plates, and surrounds the tubes. Cold water is admitted into the space at one end—the lower one when the heater is placed vertically, as it usually is—and circulates through the tubes, and is thus heated in the usual way. A marked characteristic is the corrugations of the tubes, which increases their heating surface materially and gives them some longitudinal flexibility. Different forms of this heater and their applications are described and illustrated, although the descriptions are not quite as satisfactory as they might be.

A similar use is made of corrugated tubing—which is a specialty of this company—in the construction of surface condensers, and also expansion joints for steam piping, all of

which are described and illustrated. The printing, engraving and paper in this publication are all excellent.

Proofs of "Servis." A Collection of Photographs. 24 pp., 6 × 9½ in. [not standard size]. The Q. & C. Company, Chicago.

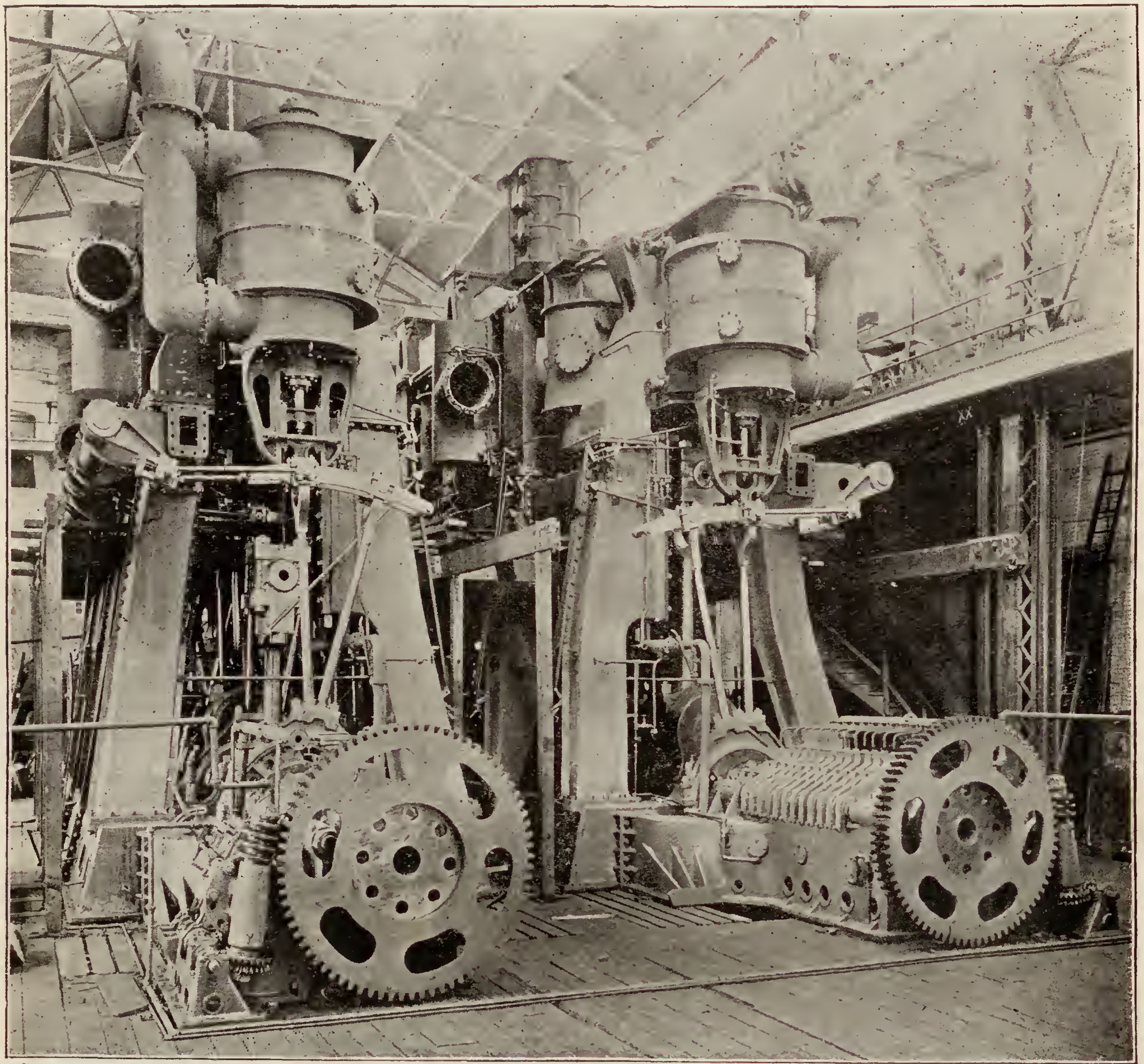
In their introduction the publishers explain its *raison d'être*, which is as follows:

"At the last annual meeting of the Road Masters' Association of America there were sent to us a large number of specimen cross-ties illustrating the mechanical failure of ties, and the protection afforded to same by the longitudinal flanges of the Servis tie-plates, which united themselves to the ties and protected the wood fibre from displacement. While on exhibition at New York, these ties were examined with considerable interest by many general officers of several different railways located in and about that city, and it was decided to select a few of the ties and exhibit them at different points. The ties herein photographed were selected, and were moved to and shown at many points, and never failed to awaken a deep interest in those who studied them. The impossibility of covering the entire country suggested a reproduction of the exhibit in album form, with a short description of each exhibit."

The ties are represented by half-tone engravings made from excellent photographs, and show the samples to good advantage. Some engravings at the end of the book show samples of worn-out plates, a diagram indicating the evolution of the tie-plate and another representing various forms of Servis plates. The use and efficiency of these appliances are well described, and the catalogue is a creditable example of this kind of literature.

THE STEAMSHIP "ST. LOUIS."

The new American Line steamship *St. Louis*, toward which so much attention has been directed during the past two years, has made her maiden voyage across the Atlantic and back. The vessel was built by the Cramp Ship-building & Engine Company for the International Steamship Company. The first frames were erected on July 23, 1893, and she was launched 15 months later. Her dimensions are: Length, 554 ft.; length between perpendiculars, 535 ft.; extreme breadth, 63 ft.; moulded depth, 42 ft.; number of decks, 5; number of watertight compartments formed by transverse bulkheads and flats, 17; distance of collision bulkhead abaft of stem, 33 ft.; displacement at 26 ft. draft, 16,000 tons.



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AFTER END OF MAIN ENGINES OF THE STEAMSHIP "ST. LOUIS."

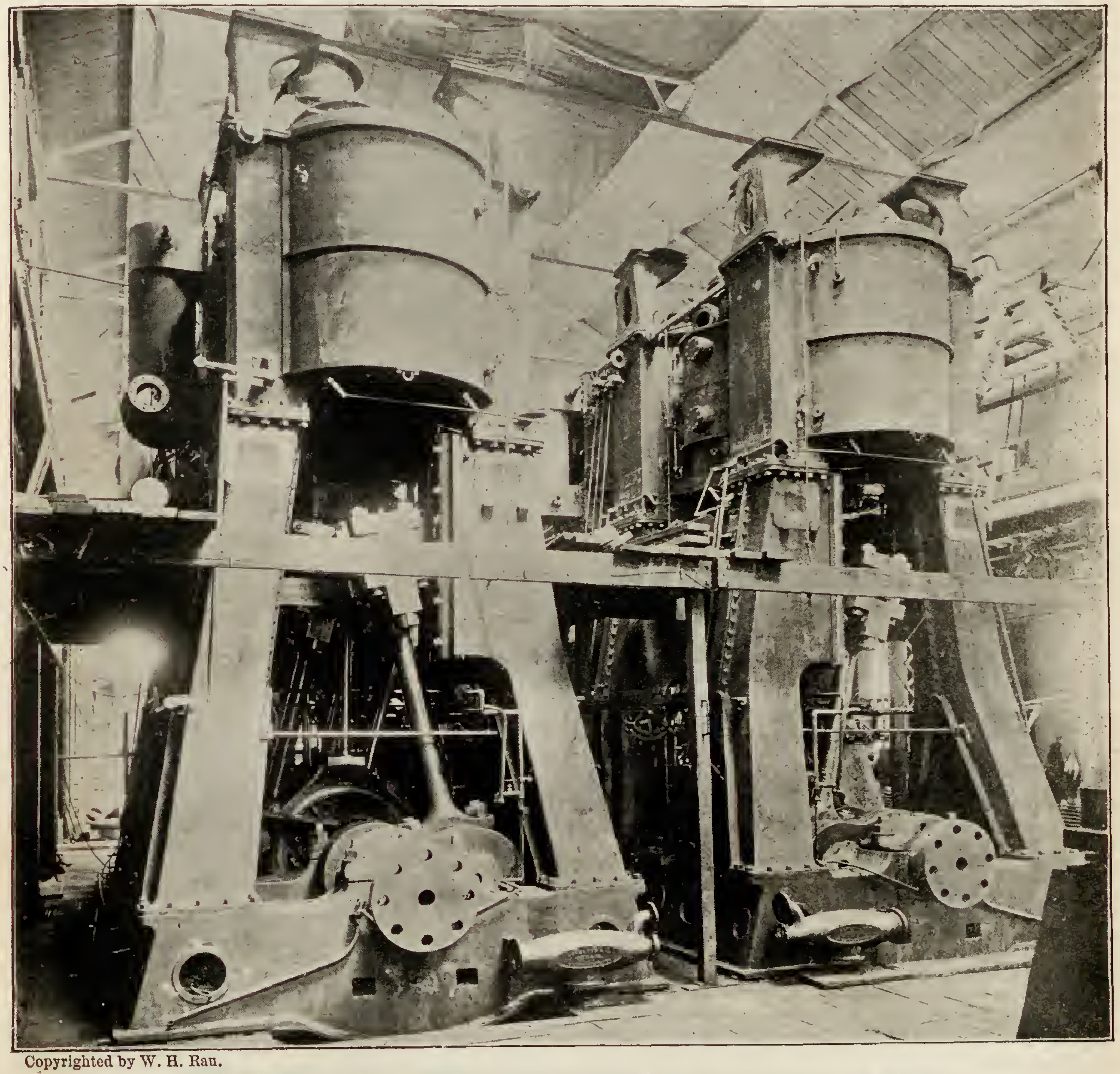
The *St. Louis* sailed on her first voyage from New York for Southampton on Wednesday, June 5, making the voyage in seven days, three hours and 53 minutes at an average speed of 18.37 knots. On the return she left Southampton June 15, and passed the Sandy Hook lightship June 22, making the voyage in 7 days, 7 hours and 11 minutes.

The company and builders disclaim all intentions of making

a record breaker of the new steamer, and instead, of making the three great requisites stand in the order of "safety, speed, comfort," the positions of the last two have been changed so that they stand "safety, comfort, speed." The *St. Louis* and her sister, the *St. Paul*, which is rapidly approaching completion, are therefore expected to be running mates of the *New York* and *Paris*, and with them to make an even and regular performance, so that the hour of arrival can be thoroughly depended upon.

The appearance of the vessel is well shown by the large engraving on page 298. It will be seen that the bow is square, and in this respect differs from the overhang or "yacht" bow of the *New York* and *Paris*. There is also another difference ing of the ship, and 12 additional ones for lighting and ventilating the vessel, independent of the propelling machinery.

The coal consumption is placed at 300 tons per day at a speed of 19 knots and a gross tonnage of 11,629. Up to the present time the vessel has had no definite trial trip, upon which the United States Government mail contracts will be awarded. This is to be a continuous run of four hours at sea at an average speed of 20 knots, and the company have until October 1 to fulfil this engagement. It is expected, however, that the vessel will make such a record on the regular runs during the summer that the official trip will be dispensed with, and that the Government will accept the vessel as a portion of the auxiliary navy.



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FORWARD END OF MAIN ENGINES OF THE AMERICAN LINE STEAMSHIP "ST. LOUIS."

n that two stacks are used on the *St. Louis*, while the *New York* and *Paris* each have three. The engravings of the engines on pages 300 and 301 are reproductions of photographs taken after the engines had been assembled in the shops. These engines are of the quadruple-expansion type, with cylinder diameters as follows: Two high-pressure cylinders, each 28½ in. in diameter; first intermediate, 55 in. in diameter; second intermediate, 77 in. in diameter; two low-pressure, each 77 in. in diameter. The boiler pressure is 200 lbs. per square inch, supplied by 10 boilers of the Scotch type, with four furnaces for each end. Six of these boilers are double-enders and four single enders, making a total of 72 furnaces. In addition to the main engines there are 49 auxiliary engines used in the work-

There are two passenger decks to the vessel, in addition to the promenade deck, and on each one has the most careful effort been expended to secure the comfort of the passenger. The uppermost deck is the promenade deck. Here is where the passengers spend most of their time. It has unusually good conveniences and spaces. Not only is there a flush deck along the entire length of the ship, but the promenade is clear from all interference by stays or benches. All along the sides of the ship are numerous alcoves, set in between buttresses formed by the spaces given up to the ventilating and heating apparatus, and in these sheltered places the cabin passengers will find room for their chairs and at the same time give an unimpeded space for the promenade. In the deck-house on

this deck are the ladies' drawing-room and elaborately furnished suites of rooms, each suite comprising bedroom, bathroom, and sitting-room. The roof of the deck-house, where all the quarters of the navigating officers are situated, is extended clear over to the sides of the ship, making a covered promenade for the passengers. Back of the chief deck-house on the promenade deck is another house, and in the forward end of this house is the first-cabin smoking-room. In the back part of this is the second-cabin ladies' saloon and the companion-way to the second cabin. Back of all this is the second-cabin smoking-room.

The main saloon also can seat the entire complement of first-cabin passengers at one time, which experienced travellers will appreciate. Moreover, there are no pillars or pipes running up through the saloon from below, and the result is that this ship has undoubtedly the most commodious and best-lighted saloon of any ship yet built. It is 110 ft. long and 50 ft. wide. It has seats for 350 passengers at one time. It is situated amidships, between the two funnels, where there is the least motion, and, with the exception of the *Paris* and the *New York*, is on a higher deck than on other ocean liners. As is the case with the *Paris* and the *New York*, it is lighted from the top by a glass dome of large proportions and graceful shape, and on the side are rectangular windows instead of port holes.

In front of this saloon, and separated from it by the main companion-way, is the library, probably the largest room devoted to that purpose on any ship. Back of the main saloon is the pantry, and backed up against that is the pantry for the second cabin. Still back of this is the second-cabin saloon, also an unusually large room, and fitted with revolving chairs at the tables instead of the usual settees. The tables in this saloon, as in the first-cabin saloon, run lengthwise of the ship. Back of this is the doctor's office and then a large space under the after promenade deck, where the steerage passengers may congregate in weather when a shelter is needed.

In the matter of decorations and fittings the same rule has been followed as in the construction of the rest of the ship. Where decorations are expected and are in good taste they are found. Where there is nothing to be gained by a useless appeal to the eye there has been no waste of money. They are most elaborate, of course, in the first-cabin saloon. This spacious apartment is finished in white mahogany. The panels about and under the glass dome are filled in with paintings of musical figures and sea nymphs engaged in playful contest in the sea. At the after end of the glass dome is a figure of Neptune with his trident, in an attitude of supremacy over the waves, and directly opposite at the forward end of the dome is a spirited figure of a mermaid holding up the gallery to the saloon in which the pipes of the great organ are placed.

The entire scheme of decoration for the ship is one of light and serviceable color. In the special suites of rooms on the promenade deck, the sides of the rooms are in panels that suggest here and there old ivory, with a slight dash of color to set off the figures. The main companion-way is stately and is in red mahogany. The ladies' drawing-room is finished in ivory color, and the upholstering is of light brocade, with a delicate figure. The library is finished in oak. The first-class smoking-room has leather fittings and dark wood. It has accommodations for 100 persons, and the fact that it is on the promenade deck is one of the novelties of the ship. It has bluish panels of attractive design, and in its centre is a glass well that gives light to the rooms below.

The second-class apartments are as pleasing to the eye as many of the first-class apartments even on ships of the present day. The ladies' sitting-room is finished in cherry, with panellings of appropriate color. The second-class smoking-room is finished in birch and cherry, and is one of the most attractive apartments on the ship.

The color scheme for the upholstery of the first-cabin state rooms is steel blue for one deck and old gold for the other. These rooms are of an unusual size, and as a rule are painted white. The ironwork is in sight in them, and in the interest of absolute cleanliness there has been no effort to cover it up with wood-work or useless decorations. The white paint makes an attractive room, and the color of the fittings give a sufficient variety to the eye to make the rooms most pleasing.

In cold weather fresh air is heated by means of ventilators near the top and the bottom of every apartment; the passenger may regulate the temperature and the ventilation as he chooses. By this superior system the inner rooms of the ship are as comfortable as the outer ones, the only difference between them being that the occupants of the outer rooms may get a glimpse of the water from the portholes. In the matter of safety, extra care has been taken with the bulkhead system, which are intact and without doors below the water-line, excepting in a few places in the engine department, where special means are adopted for closing them, and where the engineers are always on watch. The vessel is so divided that in case of collision two, and even three, water-tight compartments could be flooded and not endanger the safety of the ship. The fastening edges of the bulkheads have been made unusually secure, so that if the ship sustained a shock in that place in collision the chances are that only one compartment would be flooded. This same arrangement has been made in the engine and boiler spaces. The boilers are in two groups, one group for each funnel. They are entirely separated from each other; and if one set of boilers became incapacitated the other set could do the work of supplying steam to the engines at a moderate rate of speed. The engines likewise are cut off from each other by water-tight compartments, and it would be possible to run the ship with either engine if the other should break down.

The lighting system is also very elaborate. All told, there are more than 1300 electric lights in the ship, and four large dynamos are required in operating the exteusive electric plant.

Among the more recent of the improvements that have been introduced is the housing of the patent anchors in the hawse pipes instead of on deck, as is usually done. There is also a large post-office room, where letters are sorted by the clerks during the voyage, and in connection with which there is a mail hatch which operates something like a hod-carrier's windlass, which may be seen in operation in any large building. An endless chain with shelves at regular distances is kept in operation, and the bags are stowed on it or taken from it as it revolves.

It will thus be seen that every possible attention has been paid with the end in view of securing a vessel that combines the three requisites of ocean travel in the order already given. Even the accommodations of the steerage are fitted with baths and sleeping accommodations in excess of those usually found. The passenger capacity of the ship is: First cabin, 350; second cabin, 200; steerage, 800. The crew will number about 400.

SOME TESTS WITH FUEL GAS, CONDUCTED BY THE SOUTHERN PACIFIC COMPANY AT SACRAMENTO, CAL.

By A. J. Treat, San Francisco, Cal.

It can truly be said that neither the inventor nor the mechanical engineer has been backward in discoveries tending to greater economy in the use of steam. It is not an exaggeration to say that each day brings to life and to light some improvement in this branch of mechanics.

Unfortunately, it cannot be stated that like progress has been made in the method of *producing* steam, though it must be patent to all that its economical production is just as important as its economical utilization. Improved triple and quadruple-expansion engines, new valve gears and governors and condensers, each without number, and each warranted to effect a saving in the quantity of steam necessary to produce a given power, are urged upon the public with ever-increasing zeal; but comparatively little if anything is accomplished to effect an appreciable economy in the use of *coal*.

As a matter of fact, it is doubtful if the most improved boiler of to-day equals, in point of all-around economy, the Galloway boiler of 20 years ago. The latest style of water-tube boiler is far less bulky and a more rapid steamer, it is true; but if the question be as to dry steam and the life of the boiler, as well as the apparent evaporative efficiency; some of the comparatively old-fashioned affairs for the raising of steam are about equal to the water-tube boilers of to-day.

The difficulty in the way of a nearer approach to the obtainment of the theoretical value of coal seems to be largely one of principle. The system of burning coal to-day is practically that pursued in the days of Stephenson, and the difficulties which then presented themselves have been but partially overcome. Let us for a moment review the process:

When fresh coal is thrown into a furnace, decomposition begins first on the surface of the lumps; the moisture, of which there is always a percentage present, together with the volatile matter contained in the coal, is freed. While yielding up this volatile matter, the fresh lumps absorb heat until they too become incandescent. Unfortunately this absorption of heat and this giving off of the volatile gases occurs at a time when it is impossible to supply to those combustible gases the air necessary to their complete consumption. The particles of coal freshly thrown in lay in a mass, more or less preventing the ingress of the fresh supply of air, while the grate bars,

clogged with the ashes, add to the difficulty by keeping back the necessary supply of oxygen, which should freely pass through them, and which is so vitally essential to the consumption of the volatile gases rising in clouds from the fresh coal.

In the endeavor to overcome these difficulties, which are incident to and inseparable from the ordinary method of burning coal upon the grate bars of all the standard forms of boilers, a supply of air is admitted which is far beyond what is theoretically necessary. To obtain this supply, huge stacks are constructed, the openings for air below the grate bars—the ash-pit doors—are enlarged, or, what is least objectionable, a forced draft of air is employed.

The complicated series of gases known as hydrocarbons, set free during the decomposition of coal resulting from heat, arise, as suggested, in largest quantities when it is least possible for a supply of air to reach them. Not receiving the necessary supply of oxygen at the proper time, they are carried up the stack and into the atmosphere. A large volume of gas, capable of giving out heat, could it have been retained and properly mixed with air, is thus lost.

A single lump of coal thrown upon an incandescent bed of coals is thoroughly consumed, and nearly all its hydrocarbons utilized, because there comes to it, with but little interruption, sufficient heat and a sufficient supply of air. But where there is thrown into a furnace a charge of coal, the fresh layer forms an intervening mass between the hot bed of coals below and the gases above. In consequence, these gases, lacking the air necessary to their consumption, separate, pass up the stack, and give forth the finely divided particles of carbon commonly known as smoke. The cause and effect is similar to that of a lamp wick which has been turned too high—the gases of combustion are in excess of the air which is necessary to complete consumption.

It is not necessary to enter here into a discussion of the "smoke nuisance." By careful firing smoke can be allayed, but under present systems it cannot be prevented. A mistaken idea exists as to the amount of actual carbon contained in those dense masses of smoke which are seen rising from the tall stacks of manufacturing and other large plants. By passing through water the gases arising from a furnace burning bituminous coal, and weighing the solid particles retained or precipitated, it has been proved, it is claimed, that they amount to less than one-sixth of 1 per cent of the total amount of coal consumed. It is not strange that a different idea is entertained of the quantity of actual carbon seemingly going to waste when the wonderful coloring power of the finely divided particles of carbon is considered. To prove this it is only necessary to try the well-known experiment of smoking a bit of glass with a candle, and then mixing up with a palette knife a portion of the coloring matter thus secured with a drop or two of gum arabic. A very small portion of this mixture will color many quarts of water, and in the same proportion that the air is discolored by the dense volumes of smoke issuing from the average factory smoke stack.

Smoke, then, is the result of a condition which can be remedied to some extent, but not, under present conditions of burning coal, materially changed. Smoke is both the result and the evidence of incomplete combustion. The actual carbon contained in the smoke itself is inappreciable; but the unconsumed invisible gases invariably associated with the smoke are considerable in quantity, and indicative of a financial loss much larger than is generally known.

While it has always been understood that the generation of heat from coal, as ordinarily obtained under a boiler, was imperfectly carried on—that the gases were not, and under the conditions could not be thoroughly mixed with that quantity of air necessary to their complete combustion—singularly but little attention has been paid to possible variations of the method ordinarily employed.

At least theoretically the system of heating by gases generated in a producer carries with it the remedy for the shortcomings of the grate system of firing The difficulty heretofore, however, has been in the practical application of the system.

The process as first introduced, and which has not been materially changed, consists in distilling or volatilizing the fuel in a producer, thus turning it into its carbonic oxides and hydrocarbon gases. The first experiments with fuel gas were highly successful in the gain in evaporative efficiency, but the attempts heretofore made to introduce the system commercially have failed, mainly because of the expense formerly necessary to maintain and equip a plant, and also because more skilful handling has been required than could be expected of the average laborer found in the boiler room.

The foregoing observations upon combustion have been made somewhat in the nature of a preface to the following remarks upon and extracts from a series of experiments conducted upon lines differing slightly from those generally in vogue. The tests referred to were recently made in the boiler-room of the machine shops of the Southern Pacific Company at Sacramento, Cal. The object in view was the determination of the economy of fuel gas as against grate-bar firing, and particularly to test a patented furnace specially designed by the A. S. B. Company for the purpose of utilizing cheap coal (Ione lignite).

The tests were made by Mr. Howard Stillman, Engineer of Tests, under the direction of Mr. H. J. Small, the Superintendent of Motive Power and Machinery. The following extracts, tables, and diagram are from the report of Mr. Small to Mr. W. G. Curtis, Assistant to the General Manager:

Sacramento, February 20, 1895.

W. G. Curtis, Esq., Assistant to General Manager:

Dear Sir: Great care was taken to obtain actual data, and I can say the report very clearly exhibits the merits of the device, and we can safely say that the best efficiency from Ione coal can be obtained by its use in a gas producer. Carbon Hill coal does poorly in the producer, while Nanaimo does well.

Yours truly,

(Signed) H. J. Small,
Superintendent of Motive Power and Machinery.

Sacramento February 11, 1895.

H. J. Small, Esq., Superintendent of Motive Power and Machinery:

Dear Sir: With each fuel the tests were made on three consecutive nights, from six P.M to six A.M., the boilers supplying steam to run the electric engine. The boiler used was of locomotive type—same one as used on previous tests with gas producer—and one of a battery of three.

The test boiler was so connected as to supply steam to the electric light engine alone, though one or more of the other boilers could be cut in if necessary, as when steam pressure fell down below 40 lbs. owing to any cause.

Except with Nanaimo coal, the producer had to be cleaned out and started again at midnight of each test, a process requiring from ¾ to 1¼ hours. Under these conditions the steam pressure fell off, and it became necessary to cut in the other boiler as stated. The action of producer was irregular at times, owing to conditions producing a varying quantity of gas, conditions varying again with each fuel used. For these reasons it became necessary to study the action of each fuel in producer, and the "personal equation" entered largely into matter of successful operation. It will be understood that producer was in operation some time on working days, and trials and experiments made with each fuel to endeavor to obtain the best results. At such times the firemen in charge were instructed, and during the tests it was essential to have the same man run the producer to obtain uniform results in operation. The man in charge during the tests was allowed to run the producer without expert assistance. The Ione coal acted fairly well in the producer; the amount of heat generated in the producer was not great, and pipe conveying gas to boiler was easily kept from redness. The great accumulation of ashes from this fuel required a longer time at midnight to clean out, as above referred to.

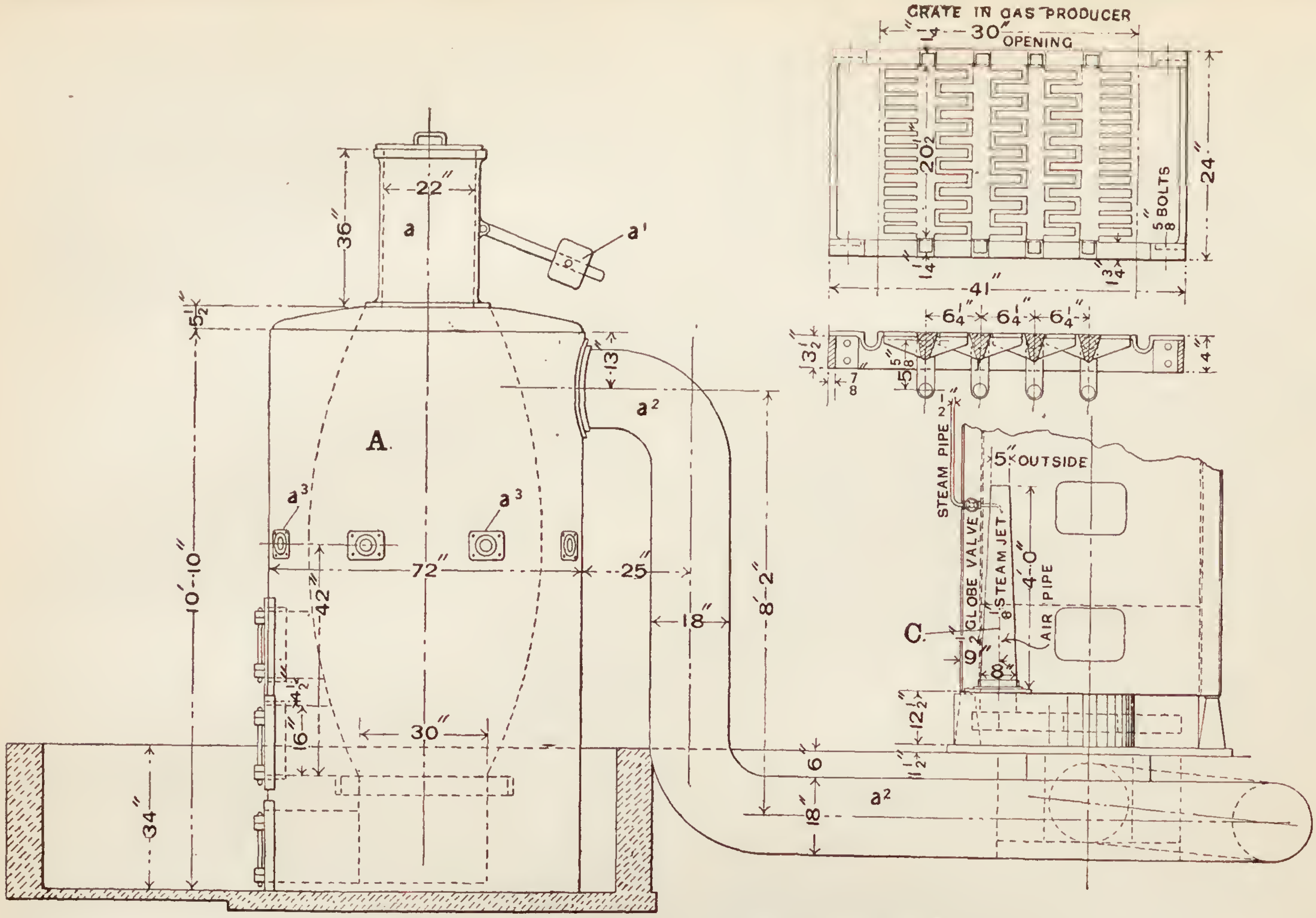
Carbon Hill coal gave much trouble, owing to difficulty in keeping the mass in producer from getting intensely hot. The gas convey pipe was red hot most of the time. To avoid this tendency the production of gas was "dragged," often to the extent of diminishing steam pressure in boiler. This again required the cutting in of other boilers to supply the deficiency, and accounts for a larger proportion of time during tests with this fuel in which the boiler was aided as shown. The accumulation of ashes, coke and clinker with Carbon Hill was also a source of midnight delay.

Using Nanaimo coal, the producer gave no great trouble with overheating of the mass. The quantity of ash and clinker were not sufficient to require cleaning out during period of each 12 hours' test with this fuel. Steam pressure was not always up to standard, but the proportion of time the boiler required aiding was small compared with the previous fuels tested, as will be seen.

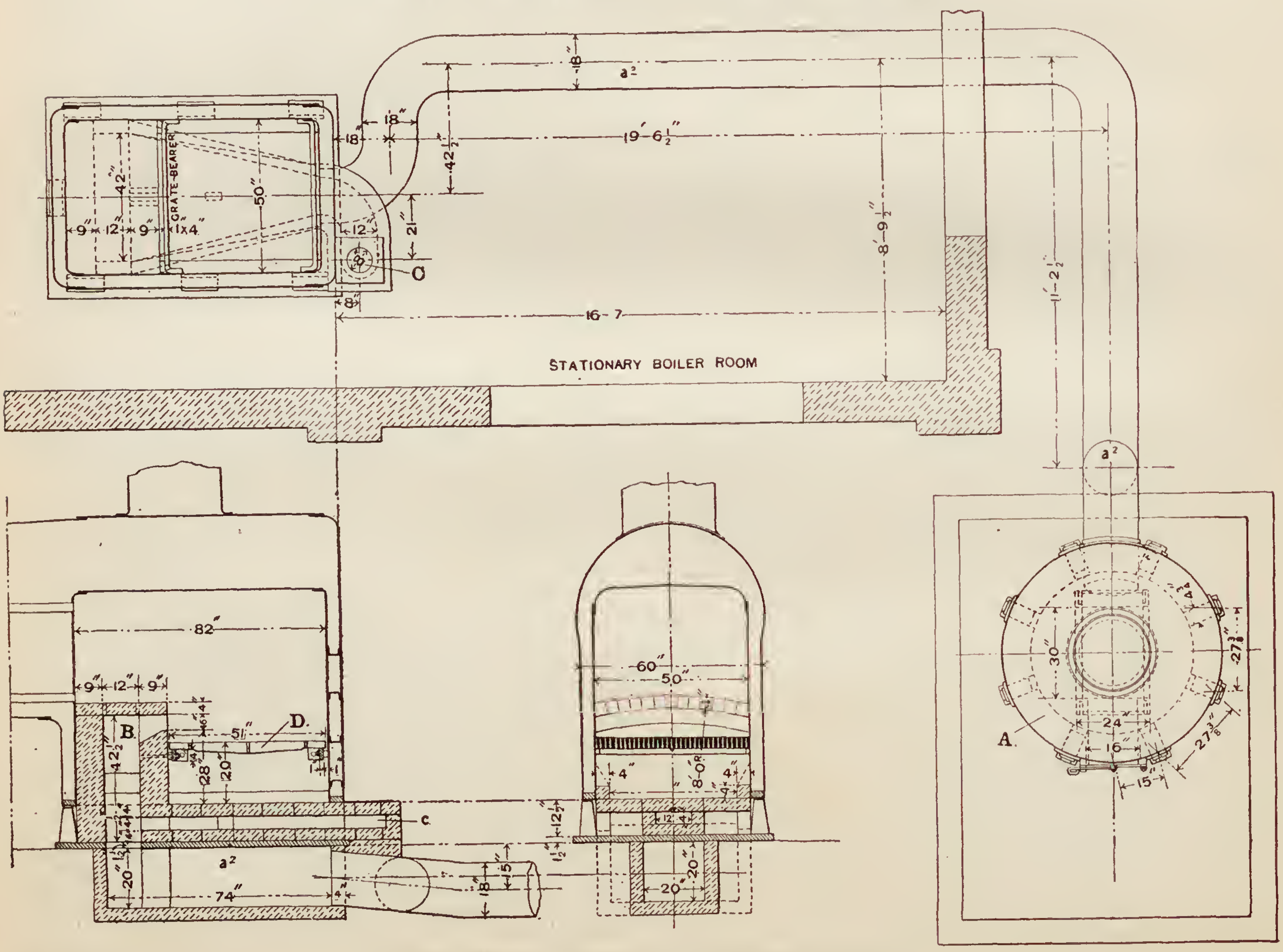
It would seem to have been shown by the tests that the producer as constructed (blue print of arrangement of which accompanies report) was not large enough to supply this size boiler.

On completion of tests with gas producer, it was disconnected and the regular grates placed in fire-box of boilers. A series of tests was then made with same fuels burned in usual manner. The figures shown in attached tabulated statement are totals and averages of three tests with each fuel and method of combustion, a total of 36 tests having been made.

(Signed) Howard Stillman,
Engineer of Tests.



ELEVATION OF FUEL GAS PLANT OF THE SOUTHERN PACIFIC RAILROAD.



PLAN AND SECTION OF LOCOMOTIVE BOILER USED IN FUEL GAS.

EXPERIMENTS ON THE SOUTHERN PACIFIC RAILROAD.

A description of the apparatus is here necessary to understand the tabulated report of Mr. Stillman.

The gas producer *A* was of the ordinary pattern, fitted with a shaking grate-bar such as is used in locomotives. Two steam-jet pipes (not shown) were arranged to the right and left of the ash-pit and cleaning doors of the producer, with valves regulating the supply of steam in the jets, and thus the supply of air entering the burning mass of coal *via* the ash-pit.

The coal was fed into the producer by the hopper *a* arranged with the usual cone valve and counter-weight a^1; the products of combustion escaped through the outlet pipe a^2 to the combining chamber *B* back of the bridge wall. Peep-holes a^3 were arranged in the outside of the producer at intervals to admit of a bar to break up clinkers.

Air was admitted or rather forced through the steam-jet pipe *C* into the passage *c*, where it met and intermixed in the combining chamber *B* with the hydrocarbon gases from the producer.

A fire was ignited upon the grate *D*, and, in addition to raising the steam to a starting-point, served to light the product from the producer when the same was rich enough for combustion, after which it was allowed to die out.

The result of the tests, and particularly the 17-per-cent. increase in the performance of the Nanaimo coal, as shown in the table, are not by any means unsatisfactory, especially when it is considered that the boiler was not the one best adapted to the tests, being of the locomotive pattern, originally intended for a river steamer. More satisfactory results would undoubtedly have been had with a boiler of the return tubular type, for then the hot gases would have had opportunity to expand and develop their greatest heat in the combustion chamber behind the bridge wall before final extinguishment in the tubes. With the combining chamber arranged as shown, in a boiler other than one of the locomotive pattern (which in this instance seriously cut down the heating area of the fire-box), a fire could also have been kept up upon the grate bars when the producer was not in use or during the period of its cleaning.

A better and a more economical result would also have followed the use of dry air, such as could have readily been had from the forge blast near by, instead of the forced draft of moist air through the steam jet pipe *C*.

The particular use to which the boiler was put—that of running an electric plant—made it difficult, with only one boiler, to properly clean out the producer at the time it became necessary without a loss in the average steam pressure, and a resultant falling off in the showing of the evaporation of water. Carbon Hill coal, however, has always shown a tendency to clinker; while the difficulty with the accumulation of ashes from the Ione coal will be understood when it is stated that its evaporative efficiency, when compared to Nanaimo, is as 1 to 3, so that in bulk three times as much would have to be used. (See table of analysis of coals.)

It will be noted, from Mr. Stillman's report, that the person in charge of the plant was the ordinary fireman. Usually tests like that described are either conducted under the supervision of an enthusiastic inventor or the watchful eye of a mechanical engineer, and the results obtained by them experimentally are seldom equalled in practice.

It is not uninteresting to note that the method of arranging the combining chamber behind the bridge wall is one applicable to most any boiler, and that, as the grate bar is not disturbed, either method of firing can be adopted according to the time the boiler is to be run.

COMPARATIVE TEST WITH FUELS IN GAS PRODUCER CONNECTED TO STATIONARY BOILER AND BURNED ON GRATES OF SAME BOILER IN USUAL MANNER, BOILER SUPPLYING STEAM FOR ELECTRIC LIGHT ENGINE ONLY.

SACRAMENTO SHOPS, FEBRUARY, 1895.

Kind of coal	Ione.		Carbon Hill.		Nanaimo.	
Method of combustion	In Producer.	On Grates.	In Producer.	On Grates.	In Producer.	On Grates.
Dates of test	Dec. 6, 7, 8.	Jan. 21, 22, 23.	Dec. 13, 14, 15.	Jan. 24, 25, 26.	Dec. 18, 19, 20.	Feb. 6, 7, 8.
Galls. water evaporated	9,280	9,475	6,200	10,090	9,834	10,634
Lbs. " "	76,704	78,927	51,648	84,050	81,920	88,582
" coal burned	29,440	33,060	9,000	13,790	11,200	14,888
Average steam pressure	63.4 lbs.	68.4 lbs.	60.0 lbs.	68.7 lbs.	64.4 lbs.	75.7 lbs.
" temperature in smoke-arch of boiler	460° F.	503° F.	475° F.	551° F.	518° F.	515° F.
Temperature feed water	58° F.	49° F.	48.6° F.	47° F.	50° F.	49° F.
Evaporation:						
Lbs. water to lb. coal	2.61	2.40	5.74	6.09	7.31	5.95
Equivalent evaporation from and at 212°	3.10	2.88	6.89	7.21	8.77	7.16
Duration of test	36 hours.	36 hours.	36 hours.	36 hours.	36 hours.	36 hours.
Percentage of above time during which the boiler was able to maintain steam pressure unaided by other boilers (above 40 lbs. required)	73 6 per cent.	100 per cent.	45.3 per cent.	100 per cent.	98.4 per cent.	100 per cent.
Lbs. water evaporated per sq. ft. heat surface	80.0	81.6	54.6	87.1	86.5	90.5
Cost per 1,000 galls. of water evaporated	$2.38	$2.60	$3.77	$3.54	$3.01	$3.64
Per cent. saving in cost per 1,000 galls. of water evaporated	8.4 per cent.	....	....	6.5 per cent.	17.3 per cent.	....
Cost of coal per ton	$1.50		$5.20		$5.20	

The report of Mr. Stillman does not state that the operation of the boiler was smokeless; nor could that fact have been readily determined, for the boiler was one of a series using a common stack. That the producer method of firing a boiler, however, *is* smokeless is a fact so well known that the statement in itself is superfluous.

ANALYSIS OF THE COALS TESTED.

(From S. P. Co.'s Analysis of Pacific Coast Fuels.)

	Ione.	Carbon Hill.	Nanaimo.
Moisture	42.58	2.16	2.25
Volatile matter	34.88	31.73	36.05
Fixed carbon	17.42	55.80	51.95
Ash	5.12	10.31	9.75
Total	100.00	100.00	100.00

THE MASTER CAR-BUILDERS' CONVENTION.

THE twenty-ninth annual convention of the Master Car-Builders' Association was called to order in the Opera House, Thousand Islands, Alexandria Bay, N. Y., on Tuesday morning, June 11, 1895, at nine o'clock by the President, Mr. John S. Lentz, who is the Master Car-Builder of the Lehigh Valley Railroad.

After the speech of welcome with which it is customary to open these proceedings, the President read his annual address, which was followed by the routine business of the Secretary's and Treasurer's reports, appointments of committees, etc. Then came the report on the interchange of cars. The report was a practical recommendation of the Chicago agreement,* with such few modifications as have been suggested by the experience of the past few months. This report was signed by Messrs. Leeds, Marden, Irwin and Barr. Mr. C. D. Nelson submitted a minority report taking exception to the statements of the majority, and arguing that the rules were satisfactory and efficient as they stand. In the discussion that followed there was much said in favor of the smooth working of the Chicago agreement; but even those speakers who are personally known to be the most enthusiastic over it, advised moderation and the postponement of any decisive or radical action for another year, and this is practically what was done when the matter was put to vote, after which there followed the usual detailed modification of the rules.

The opening of the Wednesday morning session was varied by the presentation of an exceedingly handsome badge to each of the past presidents of the Association, who are Messrs.

* See AMERICAN ENGINEER AND RAILROAD JOURNAL, January, 1895.

I. W. Van Houten, F. D. Adams, M. C. Andrews, William McWood, John Kirby and E. W. Grieves.

The reports of the two committees on brake-shoe tests are the most interesting and valuable that came before the convention. The Committee on Laboratory Tests presented a continuation of the report of last year, and while they have obtained a great mass of information, they do not feel warranted in making any recommendations as yet, but publish tables in which it is shown that, at a speed of 40 miles per hour, the coefficient of friction between a soft cast-iron shoe and a chilled wheel averages about 28 per cent., varying between 28.8 per cent. at the first application and 39.8 per cent. at the end. At 65 miles per hour these figures become 13.4 per cent. for the average, and range from 13.9 per cent to 20.5 per cent. At 65 miles per hour, and a steel-tired wheel, the figures are 8.9 per cent. for the average, ranging from 9.5 per cent. to 7.2 per cent. The report of the Committee on Road Tests enters into a detailed statement of the work done by them, and of which we give the following abstract.

ROAD TEST OF BRAKE-SHOES.

The general committee of twelve appointed by the Association (at its annual convention of 1893) to organize and conduct a series of service tests of brake-shoes, made a preliminary report (by its executive committee of three) at the convention of 1894. In that preliminary report it was stated that of the 12 railroad companies represented by the membership

STATEMENT OF BRAKE-SHOES USED IN SERVICE TESTS.

Kind of Shoe.	Made by	Address.	Number of Shoes on Cast-Iron Wheels.	Number of Shoes on Steel-Tired Wheels.	Total Number of Shoes Used in Test.
A. Soft cast iron	Pennsylvania R. R. Co.	Altoona, Pa.	Enough to wear out all the others.		
B. Hard cast iron	Ramapo Wheel & Foundry Co.	Ramapo, N. Y.	24	16	40
C. Soft open hearth steel	Solid Steel Co.	Alliance, Ohio	28	20	48
D. Hard open hearth steel	" " "	" "	28	20	48
E. Malleable iron	Dayton Malleable Iron Co.	Dayton, Ohio	28	16	44
F. Special S. T. malleable iron	" " " "	" "	24	20	44
G. Special C. W. malleable iron	" " " "	" "	28	16	44
H. Congdon	The Sargent Co.	Chicago, Ill.	28	12	40
I. Meehan	" " "	" "	28	20	48
J. Lappin	Lappin Brake-Shoe Co.	New York City	24	24	48
K. Safety	Safety Brake-Shoe Co.	Boston, Mass.	24	20	44
L. Soft steel (pressed)	Schoen Manufacturing Co.	Pittsburg, Pa.	24	20	44
M. Wrought iron (pressed)	" " "	" "	16	16	32
N. Sargent special	The Sargent Co.	Chicago, Ill.	28	16	44
Total (except the "A" soft cast iron shoes)			332	236	568

SERVICE TEST OF BRAKE-SHOES.

Condensed Statement of Results for Brake-Shoes Used on Chilled Cast-Iron Wheels.

1. Kind of Shoe.	2. Made by	3. Wear by Weight Relative to Soft Cast Iron for Same Service.	4. Net Cost Per lb. of Metal Worn, in Cents.	5. Relative Cost for Same Service, in Cents.	6. Cost Relative to Soft Cast Iron for Same Service.	7 Remarks.
A. Soft cast iron	Pennsylvania R. R. Co.	1.00	2.08	2.08	1.00	....
B. Hard cast iron	Ramapo W. & F. Co.	.86	2.81	2.41	1.16	Wear irregular.
C. Soft O. H. steel	Solid Steel Co.	.17	7.65	1.30	.62	" "
D. Hard O. H. steel	" " "	.10	7.65	.76	.36	Worn out.
E. Malleable iron	Dayton Malleable Iron Co.	.53	2.37	1.25	.60	" "
F. Special S. T. malleable iron	" " " "	.83	2.37	1.97	.94	" "
G. Special C. W. malleable iron	" " " "	.83	2.37	1.97	.94	Wear irregular.
H. Congdon	The Sargent Co.	.31	3.06	.95	.45	" "
I. Meehan	" " "	.21	6.70	2.08	1.00	" "
J. Lappin	Lappin Brake-Shoe Co.	.55	5.41	2.98	1.43	" "
K. Safety	Safety Brake-Shoe Co.	.70	3.65	2.56	1.23	Wear irregular and plugs fell out.
L. Soft steel (pressed)	Schoen Manufacturing Co.	.11	5.63	.62	.30	Cut surface of wheel.
M. Wrought iron (pressed)	" " "	.11	5.78	.64	.31	Worn out.
N. Sargent special	The Sargent Co.	.22	4.80	1.06	.51	Metal pieces fell out and broke.

SERVICE TEST OF BRAKE-SHOES.

Condensed Statement of Results for Brake-Shoes Used on Steel-Tired Wheels.

1. Kind of Shoe.	2. Made by	3. Wear by Weight Relative to Soft Cast Iron for Same Service.	4. Net Cost Per lb. of Metal Worn, in Cents.	5. Relative Cost for Same Service, in Cents.	6. Cost Relative to Soft Cast Iron for Same Service.	7. Remarks.
A. Soft cast iron	Pennsylvania R. R. Co.	1.00	2.08	2.08	1.00	....
B. Hard cast iron	Ramapo Wheel & Foundry Co.	1.06	2.81	2.98	1.43	Worn out.
C. Soft O. H. steel	Solid Steel Co.	.42	7.65	3.21	1.54	Very hard on tires.
D. Hard O. H. Steel	" " "	.31	7.65	2.37	1.14	Tires very badly worn.
E. Malleable iron	Dayton Malleable Iron Co.	.51	2.37	1.21	.58	Worn out.
F. Special S. T. malleable iron	" " " "	.67	2.37	1.59	.76	" "
G. Special C. W. malleable iron	" " " "	.81	2.37	1.92	.92	Wear irregular.
H. Congdon	The Sargent Co.	.30	3.06	.92	.44	Worn out.
I. Meehan	" " "	.21	6.70	1.41	.68	" "
J. Lappin	Lappin Brake-Shoe Co.	.35	5.41	1.90	.91	Wear irregular.
K. Safety	Safety Brake-Shoe Co.	.77	3.65	2.81	1.35	Shoes cracked and plugs fell out.
L. Soft steel (pressed)	Schoen Manufacturing Co.	.29	5.63	1.63	.78	Cut the tires very badly.
M. Wrought iron (pressed)	" " "	.29	5.78	1.68	.81	Wear irregular and very hard on tires.
N. Sargent special	The Sargent Co.	.33	4.80	1.58	.76	Metal pieces fell out and wear irregular.

of the original general committee of twelve, five (the Pennsylvania, the New York Central, the Northern Pacific, the Chicago & Alton, and the Central Railroad of New Jersey) had subsequently declined to participate in the tests. The railroads represented by the other seven members of the original general committee of twelve (the Fitchburg, the Chicago, Burlington & Northern, the Chicago, Burlington & Quincy, the Chesapeake & Ohio, the Lake Shore & Michigan Southern, the New York, Lake Erie & Western, and the Norfolk & Western) have, however, conducted a series of such service tests.

Each car under test had one truck equipped with soft cast-iron brake-shoes (all of which were made at the foundry of the Pennsylvania Railroad Company at Altoona, Pennsylvania), the other truck of each car being equipped with an outfit of some one of the 13 different kinds of special brake-shoes which are included in the test; the brake-shoes (including the soft cast-iron reference shoes) used being as given on page 306.

The equipment used by the different railroad companies in these service tests of brake-shoes has been as follows:

STATEMENT OF EQUIPMENT USED IN SERVICE TESTS OF BRAKE-SHOES.

Railroad Company.	Kind of Equipment.	With Cast-Iron Wheels.	With Steel-Tired Wheels.	Total Equipment.
Fitchburg	Pass. Equipt. Cars	..	11	11
C. B. & N.	" " "	13	4	17
C. B. & Q.	" " "	13	13	26
C. & O.	" " "	8	5	13
L. S. & M. S.	" " "	12	13	25
N. Y., L. E. & W.	Locomotive Tenders.	13	13	26
N. & W.	Pass Equipt. Cars	12	..	12
Total		71	59	130

Both of the above statements differ slightly from the corresponding statements given in the preliminary report of last year. This is partly owing to the fact that some of the railroad companies were not able to put in the exact amount of equipment originally promised, and partly due to the further fact that some of the returns made by the railroad companies had to be rejected on account of being incomplete or evidently incorrect. In still other cases, the same equipment was used for testing different kinds of shoes. The cast-iron wheels under the test equipment were principally 33-in. wheels; the steel-tired wheels were quite evenly divided between 33-in., 36-in., and 42-in.

In the preliminary report of last year the Committee pointed out that while the original intention was to calibrate the brake-beam release springs under each car used in the test, that plan was subsequently abandoned on the theory that a sufficient number of shoes of each kind were to be tried to get fair average results, under which circumstances the differences in the resistance offered by the brake beam release springs under different cars might be disregarded. In working up the results of the tests this year, the Committee concluded that they could also entirely disregard the question of brake leverages, owing to the fact that it seemed entirely safe to assume that on every car used in the test, the leverages and brake-beam pressures were the same on both trucks.

The results of the test for each variety of brake-shoe, expressed in wear, by weight, relatively to the wear of soft cast-iron (A) reference shoes, are embodied in the following statements. (In computing the average relative wear of all brake-shoes of one kind, the relative wear of brake-shoes used in Norfolk & Western equipment was doubled, owing to the fact that each Norfolk & Western truck was equipped with eight brake-shoes, whereas each truck on all other railroads was equipped with but four brake-shoes.)

Then follows a detailed statement of the results obtained with each type of shoe as compared with the soft cast-iron shoes that were taken as the standard.

In computing the relative service cost of these several brake-shoes which were under test, it was necessary to work out the actual net cost of the metal worn off. The reports from different railroad companies show that the scrap weight of brake-shoes of all kinds tested vary but little from an average of about 10 lbs. The method followed in computing the service cost was to take the weight and cost of one shoe new, and the weight and value of one shoe as scrapped; the difference in weights representing the metal worn off in service, the difference in the values representing the net cost of that metal, and the quotient arising from the division of one quantity by the other representing the net cost per pound of the metal worn off in service. The Committee obtained from each manufacturer his statement of the present selling price and scrap value of brake-shoes of his make. As the selling prices thus given by the manufacturers were, in several cases, regarded as confidential, the Committee have not thought it advisable to reproduce them in this report. The final results derived from these computations are given in the following tables:

WEIGHTS AND VALUES OF BRAKE-SHOES.

Kind of Shoe.	Made by	Weight of one Shoe. New	Weight of one Shoe. Scrap	Wearing Weight.	Net Cost of Metal Worn. Per Shoe.	Net Cost of Metal Worn. Per Lb.
		Lbs.	Lbs.	Lbs.	Cts.	Cts.
A. Soft cast iron	Penn. R. R. Co.	22.0	10.0	12.0	25.0	2.08
B. Hard cast iron	Ramapo Wheel & Foundry Co.	22.5	10.0	12.5	35 2	2.81
C. Soft O. H. steel	The Solid Steel Co.	23 0	10.0	13.0	99.5	7.65
D. Hard O. H. steel	" " " "	23.0	10.0	13.0	99.5	7.65
E. Malleable iron	Dayton Mal. Iron Co	22.6	10.0	12.6	29.8	2.37
F. Special S. T. Mal. iron	Dayton Mal. Iron Co.	22.6	10.0	12.6	29.8	2.37
G. Special C. W. mal. iron	Dayton Mal. Iron Co.	22 6	10.0	12.6	29.8	2.37
H. Congdon	The Sargent Co.	22.2	10.0	12.2	37.4	3.06
I. Meehan	" " "	22.2	10.0	12.2	81.8	6.70
J. Lappin	The Lappin Brake Shoe Co.	23.3	10.0	13.3	72.0	5.41
K. Safety	The Safety Brake Shoe Co.	19.1	10.0	9.1	33.2	3.65
L. Soft steel (pressed)	Schoen Mfg. Co.	20.0	10.0	10.0	56.3	5.63
M. Wrought Iron (pressed)	" " "	19.5	10.0	9.5	55.0	5.78
N. Sargent Special.	The Sargent Co	22.8	10.0	12.8	61.4	4.80

The final results in condensed form are given by the following statements, which show the cost (of each variety of brake-shoe) relatively to the net cost of soft cast-iron brake-shoes for the same service; the results of the tests of brake-shoes used against cast-iron wheels and used against steel-tired wheels being shown separately.

The entries in column 3 are simply the averages which appear in the footings of the detail statements given above. The entries in column 4 are taken from the last column of the statement entitled "Weights and Values of Brake-Shoes." The entries in column 5 are the product of the entries in columns 3 and 4. The entries in column 6 are simply the entries of column 5 expressed in ratios relatively to the same value for soft cast iron taken as unity. The entries in column 7 are transferred from the footings of the columns headed "Remarks" in the detail statements given above. The term "Worn Out" indicates that according to the reports, the shoes were worn down to a minimum of thickness and weight without serious trouble from breakage. The term "Wear Irregular" indicates that some shoes wore out before others of the same kind, suggesting a want of uniformity in the metal of which the shoes were made.

In considering the condensed statements of results as last above given, it should be borne in mind that the figures simply show the relative cost of different kinds of brake-shoes when subjected to the same service, but that the actual relative economic value of different kinds of brake-shoes can be determined only by combining the ratios above given with corresponding ratios, which will express the relative amount of friction produced by the application of these several varieties of brake-shoes under the same conditions. It is expected that the Committee on Laboratory Tests of Brake-Shoes will inform the Association on this point.

In the discussion Mr. Waitt said "that the committee have stated that it was not deemed advisable, owing to some practical difficulties, to make a determination as to the effect of the brake shoes on the tire of the wheels. Many of the indicators or gauges for determining or indicating the wear on tires and wheels are difficult to use or expensive. In the work that was done by the Lake Shore & Michigan Southern Road, it was determined that we would try to get as accurate an indication as possible as to what the effect was of the brake shoes on the chilled wheels and also on the steel tires. We found quite a simple and accurate method of doing this, which I would like to present to the convention, together with the data that we obtained, as such data surely has an important bearing on the question of the use of different kinds of brake shoes. Instead of using anything in the way of a gauge which might show by means of a pencil the contour of the wheel

tread, we adopted a form of flask, of which I have some blue prints and sample. The general outline is that of the tread of the wheel.

"This flask is placed over the wheel at a point which we indicate with a prick punch mark, and flask is filled with quick setting plaster of Paris, the wheel being greased so that the plaster will not stick to it. Then these casts which are in the form are labelled, indicating the number of the car and the number of the wheel and kind of shoe, etc. After the special shoes were worn out, we took a second cast, and when any changes were made we also took some casts of the wheels that were removed, and also the wheels that were applied at a similar point; making diagrams from these plaster Paris casts both before and after, we got a result, which shows something like this: the black lines on the various diagrams show the original shape of the wheel; the red lines indicate the shape of the tread of the wheel after the service; and from this we are able to judge of the comparative wearing effect of the different metals on the wheels; these are not found to be entirely in accordance with the friction. Sometimes it has been said that the shoes which will last the longest will wear the wheel the most. That was not found to be the case, the friction and the wearing properties of the shoes not being in any regular ratio. Believing that it would be interesting to the members to have this data, I will be glad to turn the diagrams over to the Secretary, if you desire to reproduce them, so that you can see what the comparative wearing qualities of the various shoes are."

The following statement was submitted by Mr. Waitt:

"It is found that the wear of the following special shoes is about equal to the wear in the same time of soft cast-iron shoes: Cast-steel shoe B, on steel wheels; Meehan shoe I, on cast wheels; malleable shoe G, on steel wheels; malleable shoe G, on cast wheel; safety shoe K, on steel wheels; safety shoe K, on cast wheels; Congdon shoe H, on cast wheels; Sargent shoe N, on cast wheels; malleable shoe F, on cast wheels; malleable shoe F on steel wheels; Lappin shoe 1, on cast wheels; Sargent shoe N, on steel wheels; malleable shoe E, on steel wheels.

"With the balance of the shoes the result was that wrought-iron shoe M, on cast wheels, more wear with special shoe and the tread of wheels badly grooved. The same shoe on steel wheels, wear on tread of steel wheels three times as much as the cast iron. The Schoen pressed-steel shoe L, wore the cast-iron wheels slightly less than the common cast-iron shoe, but on steel wheels wore the tire about 50 per cent. more. Soft open-hearth steel shoe C, on steel wheels, wore four times as much as with special shoes. Lappin shoe on steel wheel 50 per cent. more wear with special shoe. Open-hearth steel shoe D, the same. Wrought-iron shoe M, on steel wheel, wore three times as much. Meehan shoe I, on steel, wore double as much as the soft iron; the same with Congdon shoe on steel."

The Committee on the Lubrication of Cars presented a report that consisted for the most part of a *résumé* of the attempts that have been made at oil testing, and an abstract of a paper by Professor Denton on the subject that was read before the American Association for the Advancement of Science. The discussion was of a desultory character, but may be summed up in the statement that oil can be best saved by paying careful attention to its use and seeing that it is not wasted.

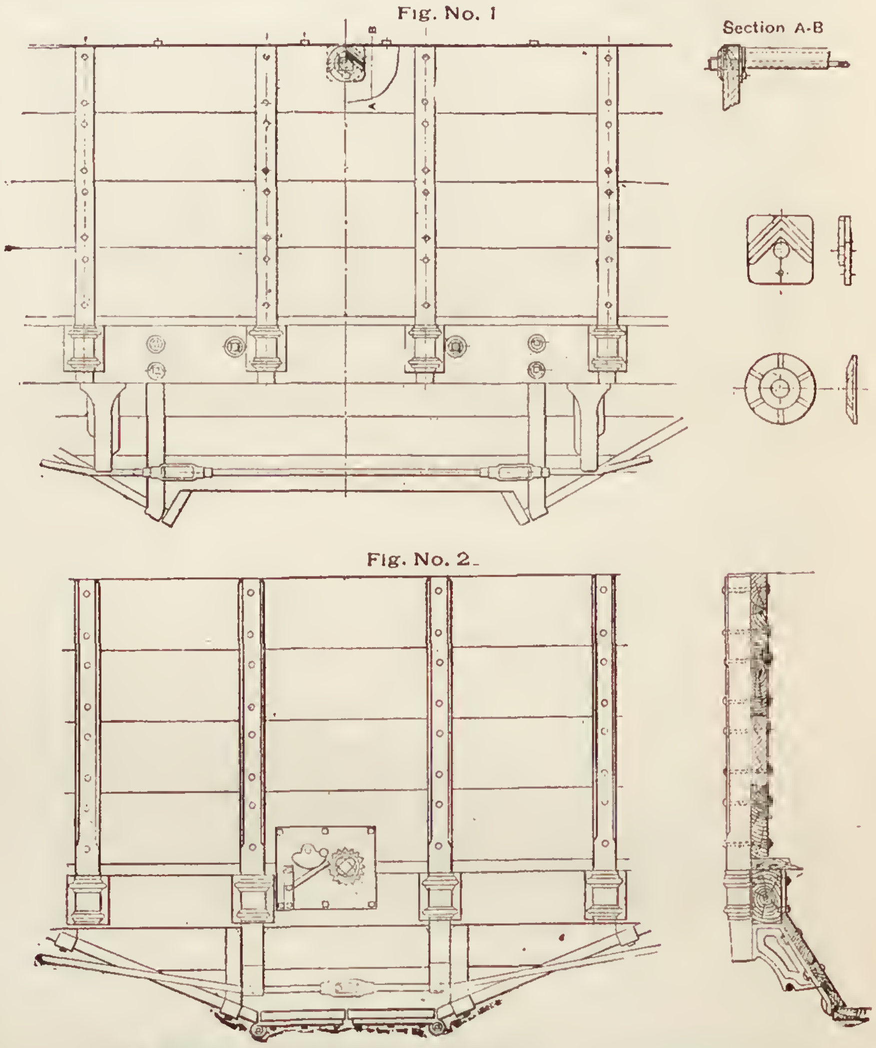
The report of the Committee on Air-Brake Tests will be of especial value to those intending to come upon the market with a new brake, by informing them of the conditions with which they must comply. Speaking of these recommendations, it was said that in recommending standard requirements this report was not recommending any one particular triple. If it is adopted as a standard, it does not compel any railroad to buy any particular triple, as out of the four tested during the past year at Altoona there was not one that could not be made to fulfil the requirement. The report on air-brake and hand-brake apparatus consisted in the presentation of a few dimensions, and the statement that there was no demand for standards in this particular, which seems to be the opinion of the convention, as the report was received and the committee discharged. The report on the strengthening of passenger car ends considered it unwise and impracticable for the Association to take any action at present, as details have not been properly worked out. There was some objection in the discussion to increasing the weight of cars for the purpose of strengthening the ends, and the Government designs, where the platforms are vestibuled and the spaces used for closets and wash-rooms, was severely criticised.

The last report presented was that on coal car sides, of which we give an abstract with the accompanying illustrations.

COAL-CAR SIDES.

Your Committee has carefully considered the methods of staying the sides of 60,000 lbs. capacity coal-cars with high sides, and is of the opinion that the most economical and efficient methods of staying the sides of these cars is by the use of a transverse tie-rod, near the top, protected by an angle iron, as shown in fig. 1.

Whenever, however, this construction is prohibited, on account of the cars being used at times to carry lumber and other lading with which this cross member would interfere, your Committee would recommend extending two stakes on each side and near the middle of the car, below the side sills and supporting them by castings having a bearing against the sides of the hopper bottoms, as shown in fig. 2, or some equivalent construction.



METHOD OF STRENGTHENING COAL-CAR SIDES.

In connection with this latter arrangement, it is desired to call attention to the fact that when the car is loaded, the weight of the lading in the hopper bottom will assist in keeping these castings out to their proper position.

Your Committee would further recommend that stakes be made as deep as practicable, and that they be spaced closer together near the middle than toward the ends of the car; also, that stake pockets be put on with a little draw, when the stakes are new, so that they can be tightened to follow up the shrinkage of the stakes.

Several devices for staying the sides of these cars have been patented, some of which have been used on a large number of cars and possess more or less merit, but your Committee has failed to discover that any of them are superior to the two methods above mentioned.

In the discussion it was the prevailing opinion that the cross-tie at the top is the only satisfactory method of tying high-side coal cars. Experience has shown that it is impracticable to keep the side truss up in proper shape, and that when loaded the sides will bulge.

Just before adjournment the Executive Committee recommended that the standard size of postal-cards be changed from $3\frac{1}{4} \times 5\frac{1}{2}$ in. to $3\frac{3}{4} \times 6\frac{1}{2}$ in., to conform to the new style adopted by the United States Government. Then, after the usual series of resolutions, in which thanks were extended to all who had rendered any courtesies to the members of the convention and their friends, the annual election of officers was held, which resulted as follows: President, John S. Lentz; First Vice-President, S. A. Crone; Second Vice-President, E. D. Bronner; Third Vice-President, J. C. Barber; Treasurer, G. W. Demarest. New members of the Executive Committee, R. H. Soule, H. S. Hayward, A. E. Mitchell. Finally, after an informal vote, by which it appeared that there was a preponderance of opinion in favor of Niagara Falls as the next place of meeting, the convention adjourned *sine die*.

BOILERS AND VESSELS OF WAR.

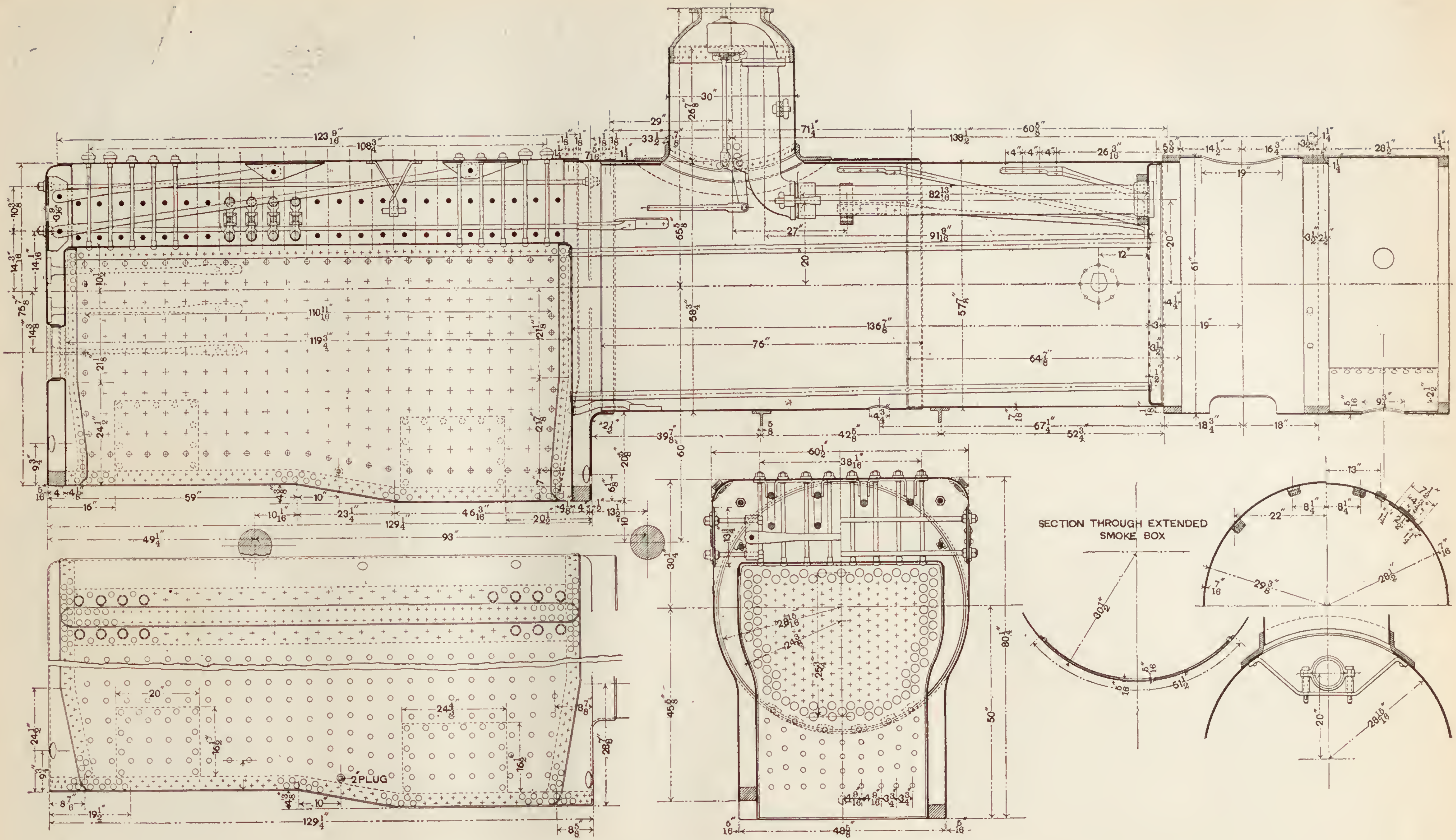
In our issue for May we published, at some length, a report of the discussions that have taken place in Parliament regarding the introduction of the water-tube boiler into the vessels of the British Navy, and the conclusion that the reader must reach therefrom is that there is a large number of persons in the country who do not approve of the course of the Admiralty in the matter of the introduction of these boilers. It is very evident from the articles that are continually appearing in the technical press of Great Britain that many engineers take exceptions to the Navy as it exists, and their criticisms frequently assume such a form that it must be embarrassing for the Admiralty to frame a suitable reply, and one which will be convincing and satisfactory. Sometimes these criticisms take the form of a story, as in the "Cruise of the Mary Rose," which was published in the *Engineer* some time ago; at others it appears in the shape of letters to the editor. These letters frequently show the touch of a master hand, and no one can read them without being convinced that the writer is thoroughly familiar with the subject that he has in hand. Such a series of letters appeared in the *Engineering* a short time ago under the *nom de plume* of "Argus."

Argus takes the position that the great mistake made by the Admiralty in the construction and arrangements of the vessels for the Navy lies in the cutting down of the boiler capacity. He says that "a ship on her measured mile trials is under conditions that never can be secured on ordinary service; then it is matter chiefly of engine power, but the ability to follow up an enemy for a considerable time, and then engage him with the knowledge and confidence that the ship's reputed speed is at command, is a question of boilers." The writer then goes on to review the gradual increase in speed that vessels of war have undergone during the past thirty-five years, during which it has risen from 14 knots to 21. He makes the especial point of his attack the inference drawn in a paper read at the Royal Institution by Dr. White, that modern ships have had to be made very much larger and heavier to allow for space and weight for the large machinery necessary for modern speeds. This, the writer asserts, is not true even approximately. "For a very moderate amount of research demonstrates that while the dimensions and displacements of both battleships and cruisers have increased enormously under the *régime* of Dr. White, the weights and spaces allotted to propelling machinery are actually less than in the era he compares with his own—less absolutely, very much less comparatively to the ship's dimensions."

Reviewing the construction of individual vessels, Argus calls attention to a comparison that has been made by Dr. White between the *Alexandra* on trial, and the run of the *Royal Sovereign* from Plymouth to Gibraltar, adding that the comparison can be extended to advantage. The engines of the *Alexandra* are of the three cylinder compound type. "The *Royal Sovereign* is 55 ft. longer and 11½ ft. broader than the *Alexandra*, and on this occasion had 5,000 tons greater displacement. That a so much larger and heavier vessel should be propelled at the same speed with less H.P. is a subject that I do not propose to discuss; but the fact remains that not only was no part of this 5,000 extra tons weight, and the corresponding internal capacity allotted to propelling machinery, but, under both heads, there was a reduction as compared with the older and smaller ship—a deduction of about 300 tons in weight, and a reduction in stokehold space equivalent to the substitution of four 15 ft. 3 in. shells for six 11 ft. 10 in. ones. Clearly, then, whatever the reasons for the greater size of the new ship might be, the provision of more weight and space for the propelling machinery was not among them." In an account that is given of the re-engining of the *Thunderer* the crux of the whole matter is shown. The old machinery weighed 1,050 tons, and the new under 800 tons; the former coal supply was 1,350 tons. The new engines are so much more economical that 950 tons of coal give the same radius of action as formerly, so that the coal and machinery together save 650 tons, which, as the author says, *can be applied to other purposes*. In point of fact the engineer is deprived of all share in the benefits accruing from his own forward progress. As soon as an improvement is made, the constructive department swoops down and appropriates it, as often as not exaggerating the saving to be made, and leaving both the engineer and the naval officer, who would like a speedy ship, in a worse plight than before. Surely some part of the saving due to engineering improvements might legitimately be applied to securing a sea speed having a nearer approximation to trial speeds than is now the rule, seeing that the difference between the two has been a standing complaint by the executive branch ever since we have had a steam navy. As each new ship is completed, or where several are built from the same specification, a representative ship is put down to her load draft, and then passed through a series of speed trials, carried out with great care by a number of men, every one of whom is an expert. The results are compared with the expectations based on model experiments, checked by the propulsive coefficients derived from the trials of earlier ships of, speaking generally, the same type, and then recorded for future reference. Between each successive series of trials an eye is kept to possible or probable engineering improvements, and in the next design these improvements are embodied to save weight and space for other purposes; but the experience derived from the actual steaming performances of the ships at sea is absolutely ignored, nothing but trial data being used for designing purposes. The Admiralty, in short, carry out a laboratory experiment on rather a large scale, with the perfectly natural result that the solution of the problems in steamship propulsion derived from such experiments are purely academical, not taking into account the personal and practical factors which so materially affect a ship's performances at sea. While these experiments are of no value to us as a means toward maintenance of our alleged naval supremacy, they are obviously of great value to foreign naval powers, as showing them what to avoid; a lesson all of the leading ones are learning and putting into practice with startling avidity."

In a later letter Argus makes a detailed comparison between certain vessels of the British Navy and those of Russia, France, and Italy, in which he shows that these countries are all devoting much more space to the boilers than is found in the English ships of corresponding size and armament. In reference to the ships of the American Navy he says: "Crossing the Atlantic we find that the Americans have adopted the precept laid down by Dr. Elgar in his paper on Fast Ocean Steamers. The author said, speaking of a large proportion of boiler power, 'The necessity for this is also well known. The best results upon short trials are obtained with large engines and small boilers, but the best results at sea are obtained with smaller engines and larger boilers. This is also an instance in which short trials fail as a standard of what can be done upon a long voyage at sea.' So the Americans put in rather larger boilers than we do, and rather smaller engines—that is, speaking generally. To secure a high speed on paper, their ships are tried at a so-called normal draft, with only a proportion of their load on board, and as the displacements published are usually those of this normal draft, the information is often misleading.

"Take the coast defence ship *Indiana*, one of a set of three sister ships. She combines the length of the *Nile* with the beam of the *Admirals*, and at 24 ft. draft has a displacement of 10,300 tons; but another 1,000 tons of coal and stores would put her down to 26 ft. draft, and then she would be simply a reduced *Royal Sovereign*, taking the mean draft and displacement of the latter ship on the trial run to Gibraltar. The speed of this run, 15 knots, was what the Americans required for a sustained sea speed in the *Indiana* class; and with 3,000 tons less displacement to drive, the *Royal Sovereign's* 8,000 H.P. would be more than ample for this speed. To provide a margin 9,000 H.P. was specified for, and to develop this power engines are fitted almost identical with those put in our *Apollo* class for 9,000 H.P. The boilers are four in number, double-ended, and in external dimensions and design generally almost identical with those in the *Blenheim*. If, then, the *Blenheim's* six boilers are good for 21,000 H.P., the *Indiana's* four boilers should be good for 14,000; but the Americans attempt no such folly. They are content, for 9,000 H.P. as a maximum, to put in boilers representing 87 per cent. of the capacity of those we put in the *Royal Sovereign* class for 13,000 H.P., and when used in conjunction with suitable engines, are ample for 15 knots, which Dr. White called an excellent result in the case of the latter ship; and there is no apparent reason why the *Indiana*, on a long run, should not be capable, if desired, of maintaining her position alongside of or ahead of the *Royal Sovereign*. The Americans, in fact, adopted that ratio of boilers to engines in this ship, which could have readily been adopted for our larger second-class cruisers. The larger American battleship, the *Iowa*, has very nearly the same dimensions as the *Tria Sviatitelia*, of Russia, and the *Jauréguiberry*, of France, and at 24 ft. of draft has a displacement of 11,240 tons. Loaded to 26 ft. she has nearly the same displacement as the Russian vessel and our *Nile;* and judging from what is said of her by English experts, she appears to be a very formidable fighting ship. Her engine power is calculated at 11,000, as much as ever could be realized in the *Nile* again, and her engines are much smaller than the *Nile's;* but she has just one-third more boilers, with similar furnaces, but placed in much larger shells, Commodore Melville being obviously alive to the vari-



BELPAIRE BOILER FOR CLASS P EXPRESS LOCOMOTIVE, PENNSYLVANIA RAILROAD.

ation in boiler design necessary for the safe and successful use of forced draft, a point that may possibly be studied at Whitehall some day. With three engines large enough for the power that could be developed in any of our later ships by their own staffs, even for a spurt, and boilers superior both in size and design, it seems as if she would be perfectly safe as against any British ship, if it was not convenient to fight.

"The Americans, with the *Alabama* in mind, have devoted serious attention to cruisers, with results of the first importance to us. One of these cruisers—the *New York*—is persistently referred to in this country as something between the *Blake* and the *Edgar*, an idea that is quite erroneous. As usually described, she is simply a reproduction of the *Blake*, floating at her normal, or trial, or, if you like, speed-premium-earning draft of 23 ft. 3 in., her displacement being 8,150 tons; but with the same coal on board as the *Blake* (1,500 tons) she draws about 25 ft. 4 in., and has the same displacement (9,000 tons), and the same coefficient of fineness as our ship at her load draft of 25 ft. 9 in. Like the *Blenheim*, she has two sets of triple-expansion engines* to each screw, and six double-ended boilers with 48 furnaces; but, unlike the *Blenheim*, the boilers are designed to permit the forced draft being used with confidence, and the engines bear some reasonable proportion to the steam-producing capacity of the boilers. The *Blenheim's* trial trip gave results unapproachable in the *New York*, but there is an end of the matter; for continuous sea steaming the advantage is with the American.

"The *Brooklyn* is a distinctly improved *New York*, with more boiler capacity, representing 50 per cent. more grate and heating surface than in our *Edgar* class, in larger and longer shells, and as a cruiser we have nothing to compare with her. Whatever power could be maintained on the *Nile* by her own staff, double that power could be maintained continuously in the *Brooklyn* by her own staff. Under all of the varying circumstances of the *Crescent's* late voyage to Australia and back, whatever power was maintained, 50 per cent. more could be maintained in the *Brooklyn*."

After making a similarly complimentary comparison in regard to the *Olympia* and the *Royal Arthur*, he continues in regard to the *Columbia* and *Minneapolis*: "Their normal draft is 22 ft. 6 in., with 7,350 tons displacement, but with 2,000 tons of coal on board, and an extra weight of 200 tons, they draw the same water as the *Blenheim*, 25 ft. 9 in., have 200 tons less displacement, and the same coefficient of fineness, and seeing that they are longer and narrower, are at least as easy forms to drive. The three engines have, collectively, the same cylinder areas as the *Blenheim's* four, and, therefore, running at the same piston speed under the same pressure, would give the same aggregate power. To supply steam the *Columbia* has six double-ended boilers, and in addition two smaller boilers, so that the *Columbia*, with at least as fine a form to drive, and the same engine power as the *Blenheim*, has all of the *Blenheim's* boiler power and some 3,500 H.P. in addition. The *Minneapolis* represents a still further advance, 14 per cent. being added to the grate and heating surfaces, as compared with the *Columbia*, which gives her just double the heating surface of our *Edgar* class. This ship, loaded to the displacement of the *Royal Arthur*, would have as much coal on board, her two side engines would indicate as much power as any two of the engines of the pattern and size of the *Royal Arthur's* have done on forced draft trials; and to supply steam there is practically double the *Royal Arthur's* boiler installation. How is this 'commerce destroyer,' then, to be destroyed? We have nothing to catch her now, and as to the *Powerful* and *Terrible*, they seem to be carricatures of the *Lepanto* or *Re Umberto*, with an extremely ill-advised experiment in boilers thrown in. Our cruisers are deprived of the one element absolutely necessary to their efficiency—namely, boilers for a high standard sea speed, in order to add something to them to increase their power as fighting ships, the result being that they will be forced to fight and probably sunk forthwith, under circumstances when, with adequate boilers, they could have escaped. Now the *Columbia* and *Minneapolis* have an amount of protection and armament which would render them formidable to an armed mercantile cruiser, but there is no inducement whatever held out to the commanders to risk their ship in an unequal encounter with a heavily armed or well-protected vessel. In the presence of a superior force they are to leave; and to secure the ability to do this the Americans have not begrudged a very large space for machinery, and a weight for it of about 2,000 tons."

The author apparently places very little confidence in the water-tube boiler as a solution of the difficulty, although he confines his actual criticism to those of the Belleville type, in regard to which we have a further discussion in another column of this issue. He says: "I can quite understand that in craft of very small dimensions and abnormally high speed, such as our new torpedo-boat destroyers, a type of boiler very much lighter than the cylindrical, or even the locomotive form, is an absolute necessity. I do not pretend to judge between the niceties of the Yarrow, Thornycroft, Normand, or similar designs, but I do say that none of them forms, in any way, a precedent for the use of the Belleville boiler in large ships. In these small fast boats rapid action is the order of the day; coal is burnt at a high rate of combustion per square foot of grate per hour; the water is circulated rapidly through the tubes, and the steam bubbles once formed are freed to do their work as early as possible. As far as I can learn, none of these quick movements are characteristic of the Belleville boiler, which appears to have its claims to notice based, not so much on speed, as on certainty of action; it is not so much the proper instrument for supplying steam for a high power in very limited room, as in the stokehold of a British warship, where it would have the best expert attention, as for supplying steam to turn the coffee-mill in a grocer's shop, and left to the tender mercies of the junior assistant. In fact, it was such considerations as these last that brought the water-tube boiler into active existence; the French authorities practically compel the use of safety boilers in towns; and so, having become the national boiler, it was inevitable that it would find its way on board ship." A long and careful review of the action of the Belleville boiler on board the ships of the Messageries Maritimes results in the conclusion that it is no more efficient for its heating surface or the space occupied than the cylindrical boiler, and that it is, therefore, a doubtful expedient to place it in vessels of large size where great power is demanded.

The conclusions reached by the author may be summed up in the statement, that the boiler capacities of the latest ships of the British Navy are ridiculously deficient in boiler power, and that the vessels will never be able to reproduce the results obtained on their trials over the measured mile; that the other navies of the world have recognized this deficiency in the English vessels and are devoting more space to the boiler installation, and that this is especially true of the United States, where the boiler capacity is made amply large for any service that the ships will be called upon to perform, a compliment to the designers of our vessels that must be gratifying to every one interested in the development of our new Navy.

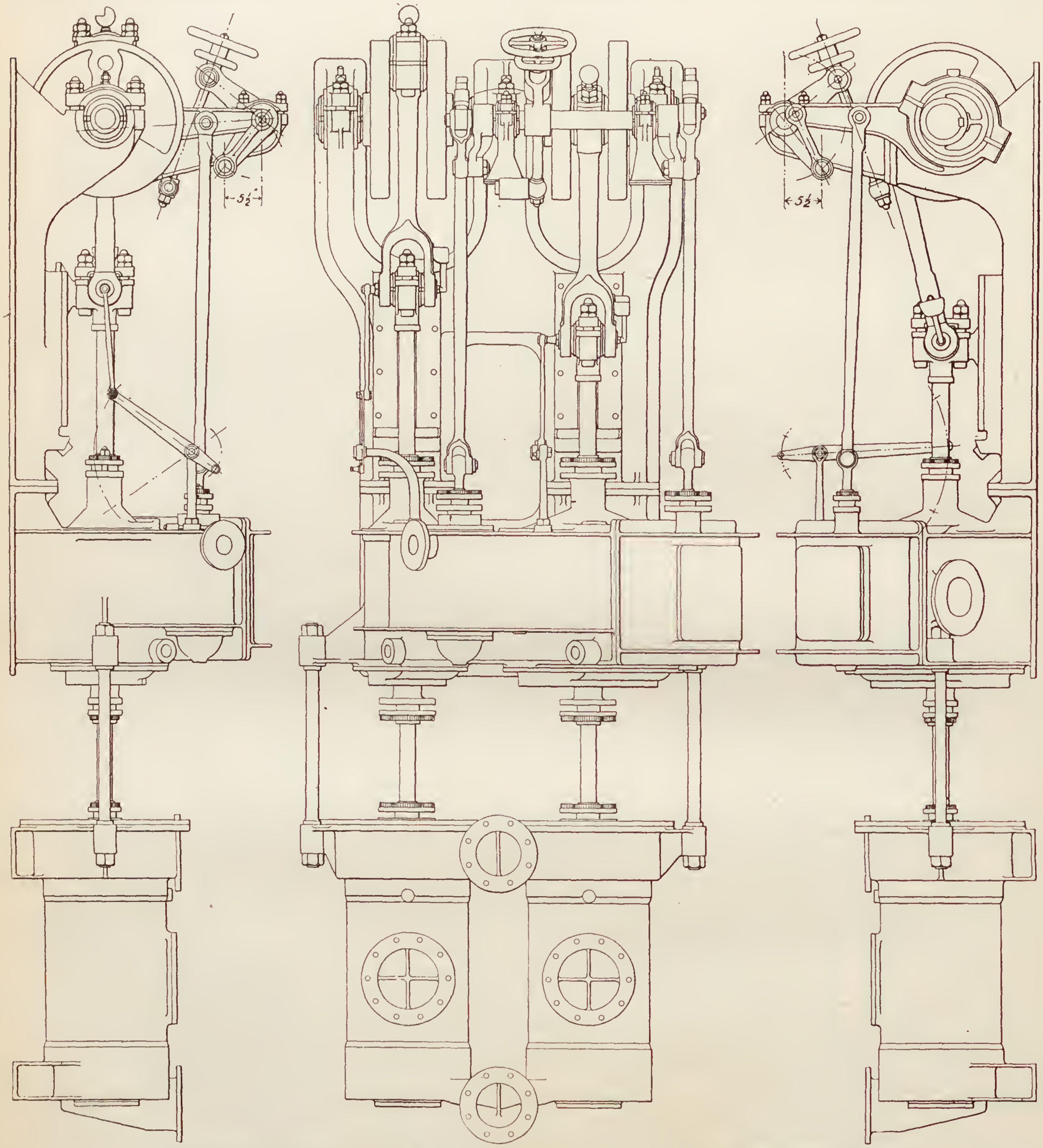
* See American Engineer and Railroad Journal for January, 1894.

BOILER FOR CLASS P LOCOMOTIVE, PENNSYLVANIA RAILROAD.

In our issue for April we illustrated the piston and cylinder used on the Class P locomotives of the Pennsylvania Railroad. The engraving on page 310 illustrates the boiler that is in use upon these same engines. It is of the straight top Belpaire type, and is constructed entirely of steel. The Belpaire boiler has given considerable trouble by leaking at the connection between the barrel and the outer shell of the fire-box, or what corresponds to the wagon-top. This difficulty has been entirely overcome in the case of these boilers by flanging the connecting sheet in line, thus making the boiler straight top. The strains of expansion and contraction are in this way brought fair against the riveting, and all working due to buckling is avoided. The flanging for the boiler is done under an hydraulic press, as described in the May issue of this paper, where the dome base was given a special illustration. The cross-section through the fire-box shows the arrangement of stays and tubes. The latter are placed in vertical rows, spaced $2\frac{1}{2}$ in. from centre to centre; they are $1\frac{7}{8}$ in. outside diameter, 11 ft. $4\frac{7}{8}$ in. long over tube-sheets, and 258 in number. The stay-bolts for the side sheets average about $4\frac{3}{4}$ in. from centre to centre on the vertical rows, the spacing being such that this is the distance apart on the sheet curved to the longer radius. The spacing of the stay-bolts on the horizontal rows is $4\frac{3}{4}$ in. They are $\frac{7}{8}$ in. in diameter, and cut with 12 threads to the inch. The crown stays are $\frac{3}{4}$ in. in diameter, spaced $5\frac{3}{16}$ in. from centre to centre on the longitudinal rows and $5\frac{7}{16}$ in. on the cross rows. The mud ring is double-riveted. The old practice of using single riveting for the mud ring has disappeared from the best practice, and with it the disagreeable accompaniment of weeping fire-boxes. In some boilers built by Mr. McKenzie for the New York, Chicago & St. Louis Railway a few years ago, single-riveting was used, except at the corners where a double row was inserted. This overcame the trouble with leaking, we believe, but the practice has not, to our knowledge, been imitated elsewhere, and a double row is now the practice. The ring has a depth of $3\frac{3}{8}$ in.; the two rows of rivets are $1\frac{1}{4}$ in. apart, and the lower one stands up the same distance from the bottom.

The barrel is composed of two courses of $\frac{7}{16}$-in. steel. Each course is made of a single sheet, with the longitudinal seams at 45° from the top for the forward and on the top for the back. These longitudinal seams are butted with an outside and inside welt. The outside welt, however, is but $4\frac{3}{4}$ in. wide, and has two rows of rivets, one in each side of the sheet, while the inner welt is of sufficient width to take the four rows. The dome is riveted to the base, which is in turn riveted to the barrel, as described in our last issue. The dry pipe has an internal diameter of 6 in., and is carried in slings riveted to the shell, as shown in one of the cross sections.

The extension of the smoke-box is of $\frac{5}{16}$-in. steel, with a liner of the same thickness on the bottom.



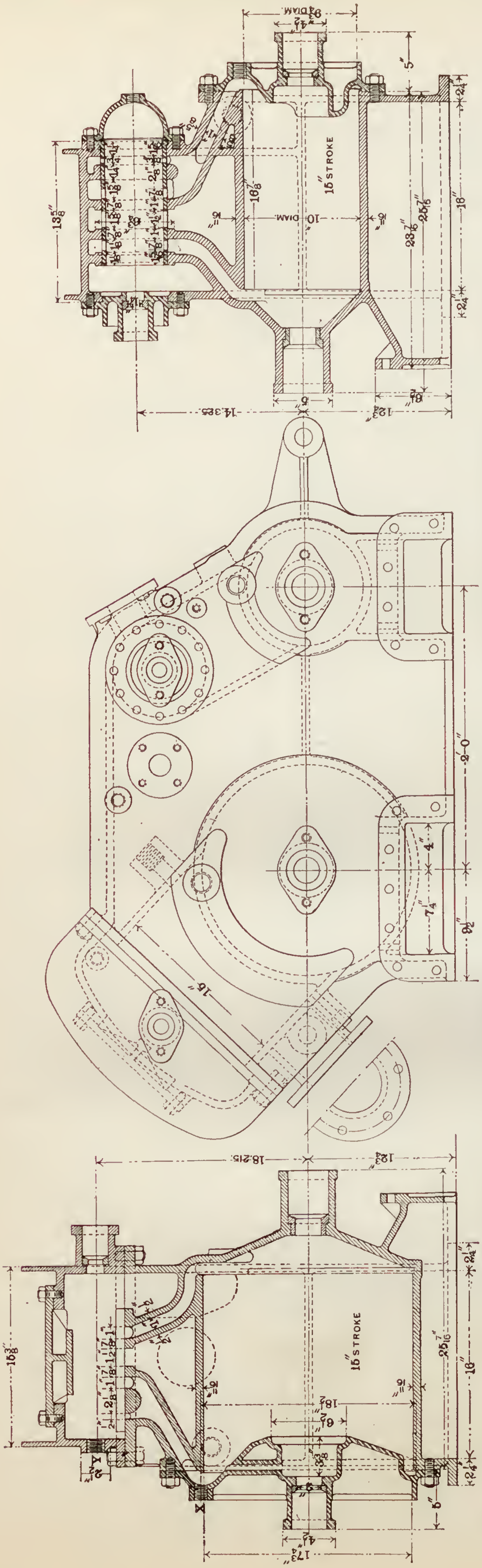
AIR-PUMPS FOR THE PROPELLING ENGINES OF THE UNITED STATES BATTLESHIP "TEXAS."

The fire-box is formed of side and back sheets having a thickness of $\frac{5}{16}$-in., and tube and crown sheets $\frac{3}{8}$-in. thick, the front tube sheet is $\frac{1}{2}$ in. thick, and the back head $\frac{5}{16}$ in. The grates have an area of 31.18 sq. ft.; the heating surface of the fire-box, deducting the sectional area of the tubes, the fire-door, and the space below the grates, is 116.64 sq. ft.; the heating surface of the tubes measured on the outside is 1,435.2 sq. ft., or a total of 1,551.84 sq. ft., making the ratio of grate to heating surface 1 to 49.77.

AIR-PUMPS FOR THE UNITED STATES BATTLESHIP "TEXAS."

We have from time to time illustrated some of the details of the machinery on the United States battleship *Texas*, and through the courtesy of the Richmond Locomotive Works, who were the contractors, we are now able to present illustrations and a description of the air-pumps used in connection with the main engines.

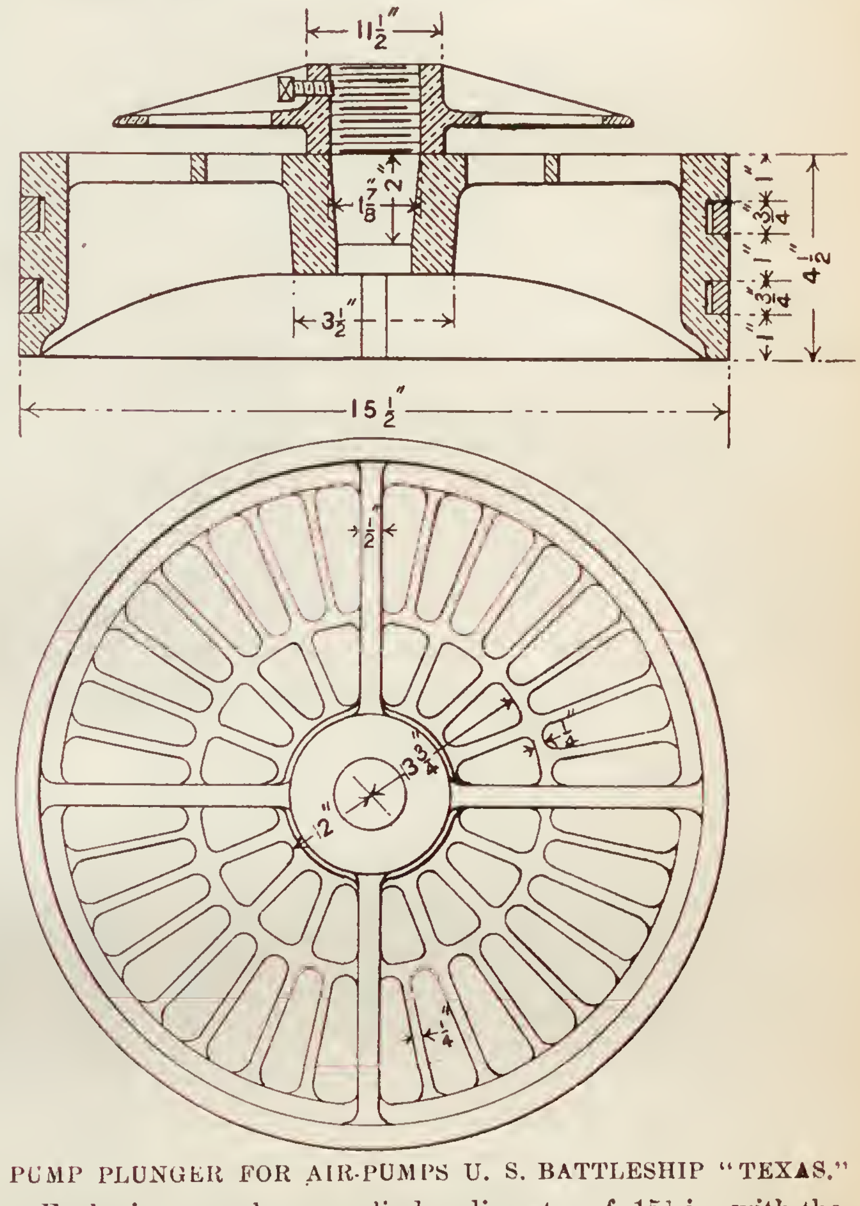
There are two single-acting, vertical air-pumps for each propelling engine; and they are worked by a two-cylinder,



STEAM-CYLINDERS FOR AIR-PUMPS OF THE PROPELLING ENGINES OF THE UNITED STATES BATTLESHIP "TEXAS."

vertical compound engine, which is placed above the pumps, the cylinders and pump barrels having a common centre line. The piston and pump-rods are made in one piece, and of manganese bronze. The engine and pump-cylinders are tied together by forged steel stays, as shown in the engraving, and the whole is bolted to the bulkheads by means of the flanges provided for the purpose and which are faced. The crank-shaft is above the engine cylinders with counterbalanced cranks standing at right angles to each other. This shaft is carried in three bearings, the central one being 10 in. long, and those at the ends 6 in. long each; the shaft itself having a diameter of 4 in. Each crank-pin is 4½ in. in diameter and 5 in. long, with a 2-in. axial hole drilled through it.

The engine cylinders are 10 in. and 18 in. in diameter, with a common stroke of piston of 15 in., and are bolted together, as shown on the engraving. The high-pressure cylinder is operated with a piston-valve, and the low-pressure with slide-valve, both being worked with the Marshall valve-gear. The cylinders, steam-chests, and engine frames are made of cast iron; steel castings are used for the pistons and cylinder covers; forged steel for the crank-shafts and connecting-rods, and cast steel for the crank webs and crank-pins. Each of the pistons is packed with three cast-steel rings sprung into place.

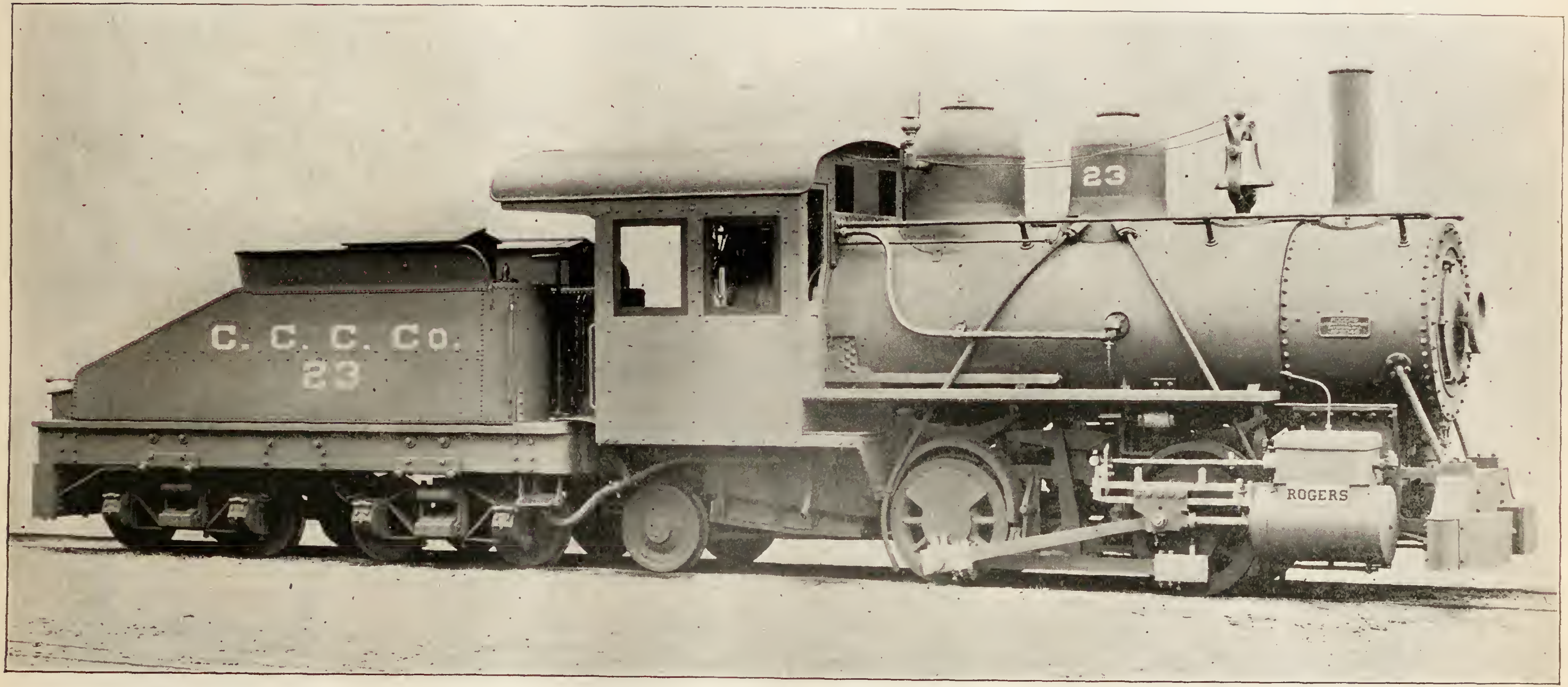


PUMP PLUNGER FOR AIR-PUMPS U. S. BATTLESHIP "TEXAS."

Each air-pump has a cylinder diameter of 15½ in. with the same stroke as the engines. The pistons are thoroughly ribbed, so as to secure ample strength for the work which they have to perform. They are turned to an accurate fit for the pump barrel, and packed with two brass rings sprung into place; there is also a grating in the pistons and guards, as shown by the engraving.

Each pump is provided with one foot-valve, one piston-valve, and one delivery valve; the seats and guards for each being provided with gratings, as given for the piston. Each valve consists of three disks of sheet brass $\frac{1}{32}$ in. thick, and of suitable diameters for the work. While these valves are held firmly in place, they are easily removed, the seats also being made separate from the pump casings and bolted in place. It will also be noticed that the design of the pump is such that there are no pockets in the pump chambers beneath the piston-valves where vapor can lodge.

All bolts and studs in the water space of the pumps is made of delta metal, and, for purposes of inspection, there is a round hand-hole, 9 in. in diameter, fitted with a cover, in the front of each pump barrel.



SWITCHING LOCOMOTIVE FOR THE CROSS CREEK COAL COMPANY, BUILT BY THE ROGERS LOCOMOTIVE COMPANY.

The air-pumps discharge into a feed tank placed in the forward part of each engine-room, and each one, together with its condenser, is expected to maintain a vacuum within 4 in. of the mercury of the atmospheric barometer, when the propelling engines are working at full power under a forced draft.

Like the other machinery that has been especially designed for this vessel, space has been of the first importance, and with this end in view the pumps illustrated have been designed. Bolted to the bulkhead they have no floor attachments, and occupy a horizontal area of 5 ft. 1 in. × 3 ft. 1 in. As already noted, the valves are driven by the Marshall gear, and are arranged in accordance with the following details :

	Top.	Bottom.
Lead	$\frac{3}{32}$ in.	$\frac{3}{32}$ in.
Lap	$\frac{7}{16}$ in.	$\frac{7}{16}$ in.
Cut-off	75 per cent.	75 per cent.
Compression	88 "	95 "

SWITCHING LOCOMOTIVE FOR THE CROSS CREEK COAL COMPANY.

The Rogers Locomotive Company, of Paterson, N. J., has recently built a switching locomotive for the Cross Creek Coal Company of a striking design. It is of the Forney type, except that the trailing truck has but two wheels, and these are not used to carry the coal and water supply. The cab, as will be seen, is entirely metallic, and is carried on a footplate built out beyond the front end and carried by a brace bolted to the frame just back of the rear driving-wheel. The driving-wheel brakes are operated by a cylinder bolted to the under side of the running board acting upon a vertical lever coming down outside the frames. The following is a list of the principal dimensions of this locomotive :

DESCRIPTION.

Gauge	4 ft. ¼ in.
Fuel	Anthracite coal.
Weight on drivers	56,000 lbs.
" " truck-wheels	8,000 lbs.
" total	64,000 lbs.
Wheel base, total engine	13 ft. 8 in.
" " driving	6 ft.
Height, centre of boiler above rails	6 ft
" of stack above rails	11 ft. 8 in.

WHEELS AND JOURNALS.

Drivers, number	4
" diameter	36 in.
Truck-wheels, kind	Chilled cast-iron.
" diameter	26 in.
Journals, driving axle, size	7½ in. × 9 in.
" truck axle, size	5 in. × 12 in.
Axles, driving material	Hammered iron.
" truck "	Hammered iron.

CYLINDERS.

Cylinders, diameter	14 in.
Piston stroke	20 in.
" rod, diameter	2½ in.
Kind of piston-rod packing	Jerome metallic.
Steam ports, length	12½ in.
" " width	1¼ in.
Exhaust ports, length	12½ in.
" " width	2½ in.
Bridge, width	1¼ in.
Exhaust pipe	Single.

VALVES.

Valves, kind of	Richardson's balanced.
" greatest travel	4½ in.
" outside lap	$\frac{11}{16}$ in.
" inside lap or clearance	Line and line.
" lead in full gear	$\frac{1}{16}$ in.

BOILER.

Boiler, type of	Straight top.
" working steam pressure	175 lbs.
" material in barrel	Central I. & S. Co.'s Steel.
" thickness of material in barrel	$\frac{7}{16}$ in. and ½ in.
" diameter of barrel outside at first course	52 in.
Seams, kind of horizontal	Quadruple-riveted butt.
" " " circumferential	Double riveted lap.
Crown sheet stayed with	Crown bars.
Dome, diameter	28 in.

TUBES.

Tubes, number	159
" material	Iron.
" outside diameter	2 in.
" length over sheets	9 ft. 11 in.

FIRE-BOX.

Fire-box, length	4 ft.
" width	3 ft. 9½ in.
" depth, front	60 in.
" " back	54 in.
Firebox, material	Central I. & S. Co.'s Steel.
" thickness of sheets	Flue sheet, ½ in.; crown, ⅜ in.; sides and back, $\frac{5}{16}$ in.
" brick arch	None.
Grate, kind of	Stationary bars with drop p ate.

TENDER.

Tank capacity	1,600 galls.
Coal "	3 tons.
Frame, type of	White oak.
Trucks, " "	Diamond.
Wheels, kind	Chilled cast iron.
" diameter	26 in.
Axle, material	Hammered iron.
Journals, size	3¾ in. × 7 in.
Brake on drivers	American Steam.

EARLY PASSENGER TRAFFIC ON RAILWAYS.

In a recent number of the *English Mechanic* (May 17) Mr. Clement E. Stretton, the indefatigable railroad historian, has given the following interesting account of early passenger traffic on English roads :

" Questions are frequently asked with reference to the first introduction of passenger trains, and as to the early dates at which persons were conveyed by means of locomotive engines running upon iron rails.

" The answers usually given do not agree, for the simple reason that the questions are so extremely vague.

" As I pointed out to the authorities of the Transportation Department of the Chicago Exhibition two years ago, the very first step necessary toward ascertaining the required particulars is to divide the question into three important periods—viz.:

" 1. The conveyance of persons by locomotive power upon private lines.

" 2. The conveyance of passengers by mixed trains—that is, in carriages attached to coal or goods trains.

" 3. The conveyance of passengers by complete passenger trains.

" Under heading No. 1 there can be no question that the first persons ever conveyed by a locomotive upon rails travelled on February 24, 1804, behind Trevithick's locomotive on the Pennydarran cast-iron plate-way, or tram-road, to Merthyr Tydfil, a distance of 9 miles. In order to convey long bars of iron, and also timber, wagons were constructed in pairs coupled together by an iron drawbar, having a joint at either end ; these wagons had no sides, but in the middle of each there was fixed a centre-pin, upon which worked a cross-beam or bolster, upon which the timber or bars of iron were placed.

" The trucks in this case were loaded with 10 tons of bar iron, and upon the iron 70 persons either stood or sat.

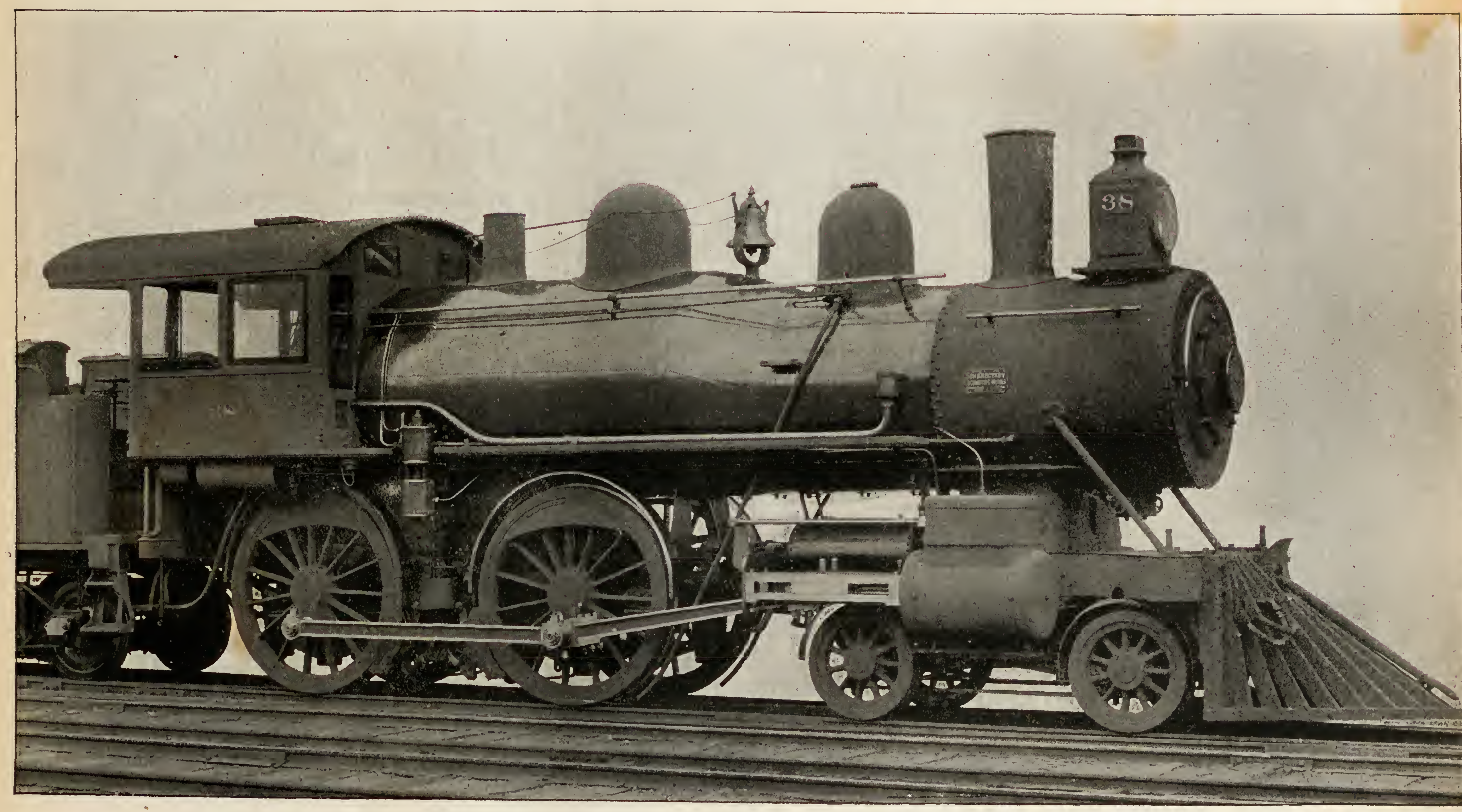
" There can be no doubt that these '70 persons' were specially invited to witness the trial, and cannot, therefore, be considered as railway passengers.

" In the year 1808 Trevithick had a circular experimental railway in London, near Euston Square and the site of the present London & Northwestern station, and upon this circle his engine, named *Catch-me-who-can*, ran round and round the circle at 12 or 15 miles an hour, and conveyed the general public at 1*s*. a head. This is certainly the first occasion upon which passengers paid to ride behind a locomotive ; but it can only be regarded as an experimental run—not as a railway journey.

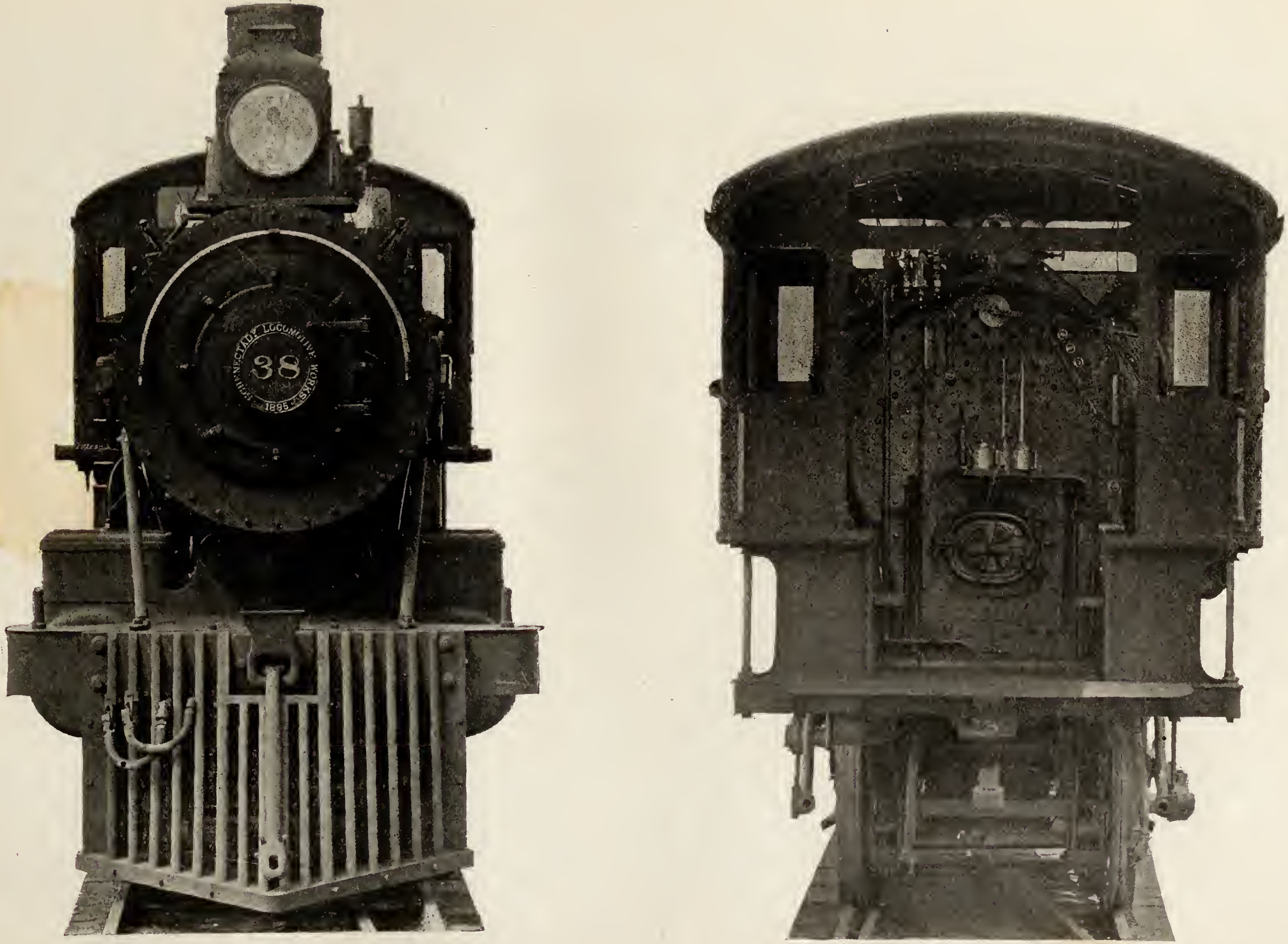
" In August, 1812, Mr. John Blenkinsop, the proprietor of the Middleton Colliery, Leeds, had an engine placed upon his railway, named the *Blenkinsop*, which had been constructed for him by Matthew Murray, of Leeds.

" Mr. Blenkinsop had a small covered vehicle constructed, in order that he and his managers could travel over the line. In order to convey the workmen from Leeds to Middleton Colliery, a distance of 3½ miles, the locomotive started every morning at 5.30 with a train of empty wagons, in which the workmen rode, and returned with a loaded coal train at 6 at night, the men then returning on the top of the coal. That arrangement of conveying workmen to and from work is believed to have existed from that day to the present time.

" George Stephenson's first locomotive, named the *Blucher*, was completed and tried for the first time upon the Kenilworth Colliery railway on July 25, 1814, and two days later it conveyed a train of wagons from one end of the line to the other. Lord Ravensworth and a party of his friends rode in the wagons, and having seen that the engine was a success, Lord Ravensworth ordered that the body of one of his four-in-hand coaches should be taken off its wheels and placed upon a wooden frame having flanged wheels. This early passenger coach was in use for over twenty years, and Lord Ravensworth and the officials of the colliery constantly used it when travelling over their line.



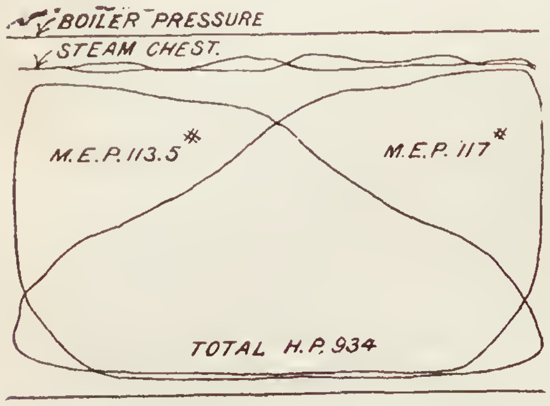
PASSENGER LOCOMOTIVE FOR THE CONCORD & MONTREAL RAILROAD, BUILT BY THE SCHENECTADY LOCOMOTIVE WORKS, SCHENECTADY, N. Y.



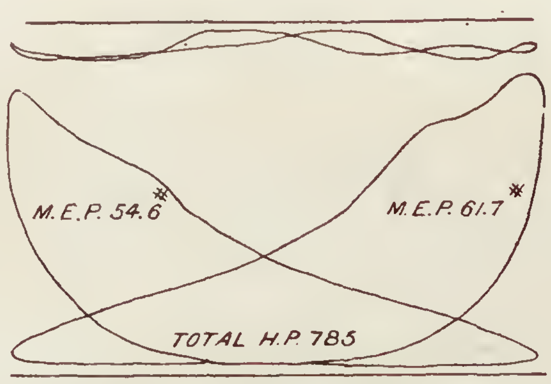
FRONT AND REAR VIEWS OF EXPRESS PASSENGER LOCOMOTIVE, BUILT BY THE SCHENECTADY LOCOMOTIVE WORKS FOR THE CONCORD & MONTREAL RAILROAD.

"The Duke of Portland, in 1817, followed almost exactly the course taken by Lord Ravensworth, for he had the body of one of his carriages placed on a frame in order that he could travel behind the locomotive upon his Kilmarnock & Troon tram-road; but its use was afterward given up, as the cast-iron tram-plates proved too weak to carry any engine, and ultimately the Duke of Portland sold both the engine and carriage to the old Gloucester & Cheltenham Tramway Company.

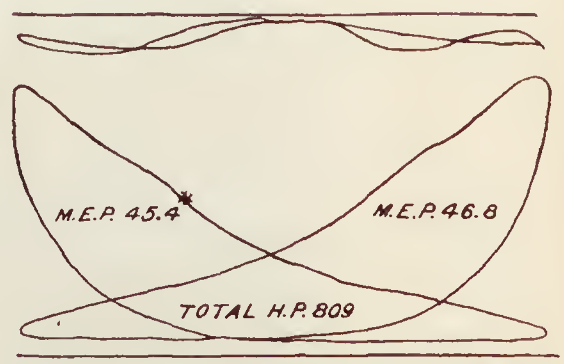
"With reference to heading No. 2, the Stockton & Darlington Railway was opened on September 27, 1825, and the trains



New York Central Train 63, June 8, 1895: 120 revolutions per minute; 25 miles per hour; 195 lbs. pressure; throttle wide open; cut-off, 12 in.; vacuum, 4 in.; working, 90 ft. grade out of Albany.



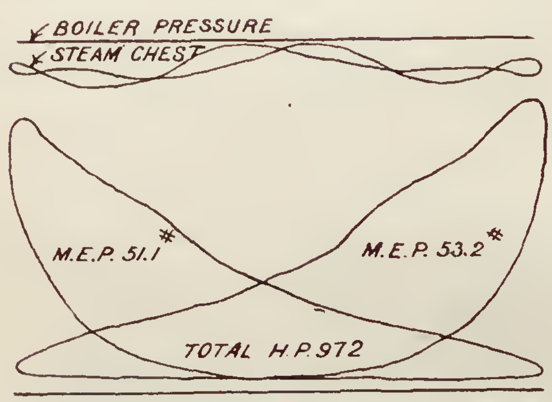
New York Central Train 63, June 8, 1895: 200 revolutions per minute; 41½ miles per hour; 190 lbs. pressure; throttle wide open; cut-off, 6 7/16 in.; vacuum, 3¾ in.



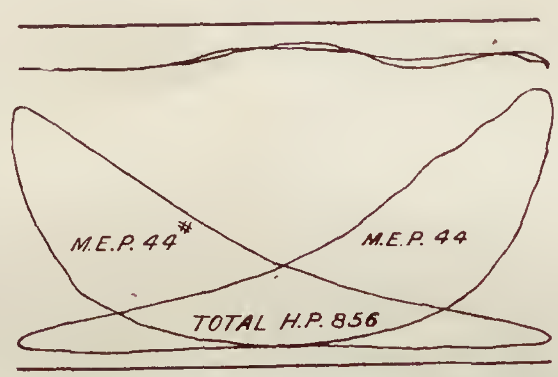
New York Central Train 63, June 8, 1895: 260 revolutions per minute; 54 miles per hour; 182 lbs. pressure; throttle wide open; cut-off, 6 7/16 in.; vacuum, 4¾ in.

were conveyed by the company's engine named *Locomotion*, and consisted of coal wagons and one passenger coach named *Experiment*. This vehicle ran upon four wheels, had a door at each end, and three windows at each side, a row of seats ran along each side of the interior, and a long deal table was fixed in the centre.

"For ten days this carriage was attached to coal trains, but the delays caused by shunting at sidings were so considerable



New York Central Train 63, June 8, 1895: 276 revolutions per minute; 57 miles per hour; 186 lbs. pressure; throttle wide open; cut-off, 6 7/16 in.; vacuum, 4 in.



New York Central Train 63, June 11, 1895: 288 revolutions per minute; 60 miles per hour; 185 lbs. pressure; throttle, ½ open; cut-off, 6 7/16 in.

that the stage-coaches on the road had no difficulty in beating the railway train, often by more than an hour. It naturally followed that the passenger traffic, which at first was small, was in a few days almost, if not completely, killed, and the company therefore decided to abandon 'mixed' trains, and to let the *Experiment* to a contractor, who worked it with his own horses and paid rent and toll to the company. This arrangement continued for several years, and passengers were not again conveyed by locomotives upon this line until after the Canterbury & Whitstable, Liverpool & Manchester, and Leicester & Swannington lines had been opened.

"On May 3, 1830, the Canterbury & Whitstable Railway was opened, and was worked by fixed engines over the inclines, and by the locomotive *Invicta* on the level portion.

"'Mixed' trains were introduced; one, and sometimes two, passenger carriages being attached to the goods trains.

"So far it will be seen that no complete passenger train had been run; but on September 15, 1830, the Liverpool & Manchester Railway was officially opened by the directors and their friends, upon which occasion the company's eight engines and trains, and about 600 people started in a procession from Liverpool. On the following day, September 16, 1830, the Liverpool & Manchester Railway was opened for regular public passenger traffic, and several passenger trains ran daily between the two cities.

"In answer, therefore, to Question 3 it will be seen that the first complete passenger trains commenced work on September 16, 1830.

"CLEMENT E. STRETTON, C.E.

"SAXE-COBURG HOUSE, LEICESTER."

PASSENGER LOCOMOTIVE FOR THE CONCORD & MONTREAL RAILROAD.

THE accompanying photographs of side elevation, front, and rear view illustrate a heavy passenger locomotive recently designed and constructed by the Schenectady Locomotive Works for the Concord & Montreal Railroad.

In designing the locomotive the builders were restricted to a weight on driving-wheels not exceeding 76,000 lbs. In order to reduce to a minimum the evil effect of reciprocating parts on the track through the counter-balance of driving-wheels, the piston, cross-head, connecting-rods, crank-pins, and wheel-centres were reduced to the minimum weight, so that the effect on the rail at a speed of 60 miles per hour is only equivalent to the ordinary construction of American type of engine, with cast-iron driving-centres, weighing 9,000 lbs. less on drivers.

The driving-wheel centres are of cast steel and of very light weight, crank-pins are hollow, while the connecting rods, cross-heads, and piston are greatly reduced in section from ordinary practice.

Particular attention was paid to making the locomotive convenient for engineer and fireman; the arrangement in cab of reverse-lever, throttle-lever, and all operating valves is such that they are as conveniently located as in the ordinary American type of locomotive having a deep fire-box boiler.

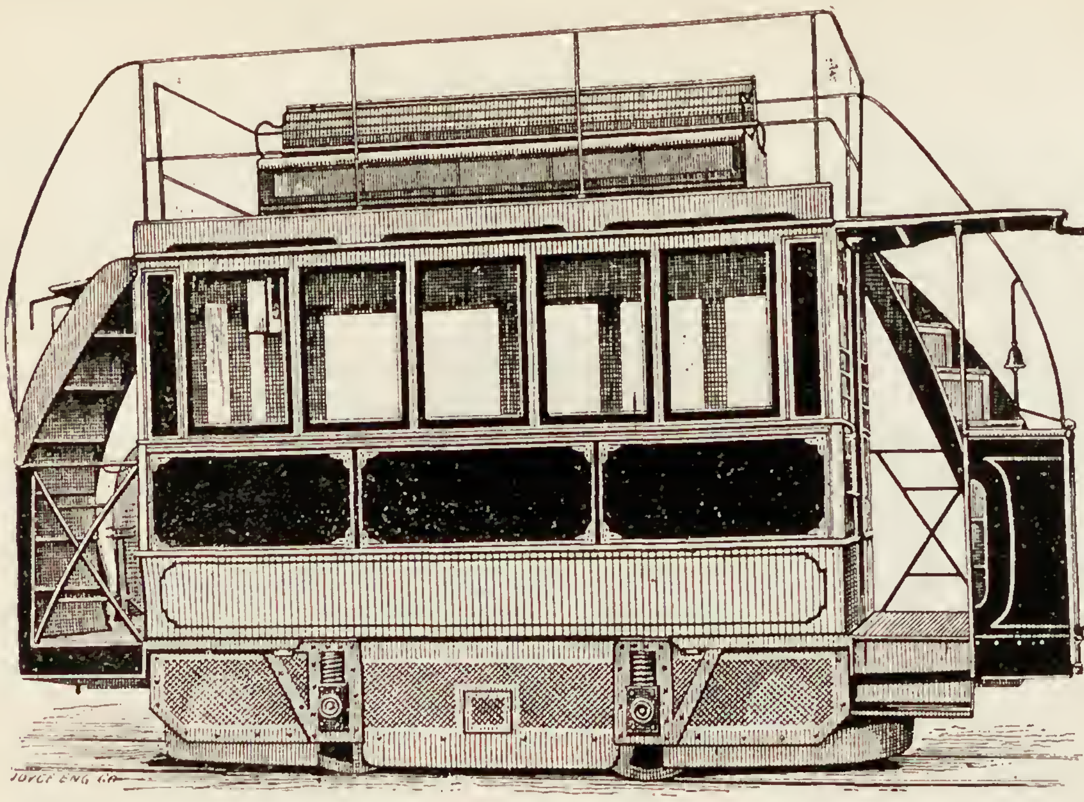
As will be seen by photograph and specifications, the boiler is of the extended wagon-top radial stay type with wide fire-box, extending out over frames and over back driving-axle and sloping down toward front end, giving a depth of 25 in. below shell of boiler, thereby allowing ample space for fire between grates and fire-brick.

The general design of the engine is similar to the 16 engines recently built by the Schenectady Locomotive Works for the Boston & Albany Railroad.

The following are the principal dimensions and weight of the engine:

Cylinder diameter	19 in.
Piston stroke	24 in.
Driving-wheels, diameter outside of tires	70 in.
" " of centres	63 in.
Driving-wheel centres of east steel, tires held by retaining rings.	
Boiler, extended wagon top, radial stayed.	
Working pressure	190 lbs.
Boiler diameter at front end	60 in.
" " back end (back-head a true circle)	70 in.
Fire-box, inside length	90 in.
" width inside	40½ in.
" depth at back end	61¾ in.
" " front end	73¾ in.
Tubes, number of	299
" diameter	2 in.
" length	11 ft. 6 in.
" space between	¾ in.
Weight of engine in working order	116,400 lbs.
" on drivers	75,000 lbs.
Total wheel base of engine	23 ft. 9 in.
Driving-wheel base of engine	8 ft. 6 in.
Driving-axle journals	8 × 11.
Engine truck journals	6 × 10.
Tender " "	4½ × 8 in.
Diameter of engine truck wheels	36 in.
" " tender " "	36 in.
Tank capacity	4,000 galls.

Tender frame is made of 6½ × 4 × ¾ angle iron.



THE GAS-MOTOR CAR IN DRESDEN.

The tender trucks are the Schenectady Locomotive Works standard iron truck, with channel iron floating bolsters and inside brakes.
Engine and tender truck-wheels are the Snow boltless steel-tired wheel.
Locomotive is fitted with the Westinghouse air-brake on driving-wheels, tender, and train; Westinghouse air signal, Richardson balance valves, Leech sand-feeding device, Nathan & Co. sight-feed cylinder oiler, Hancock inspirators, and Smith triple-expansion exhaust nozzles.

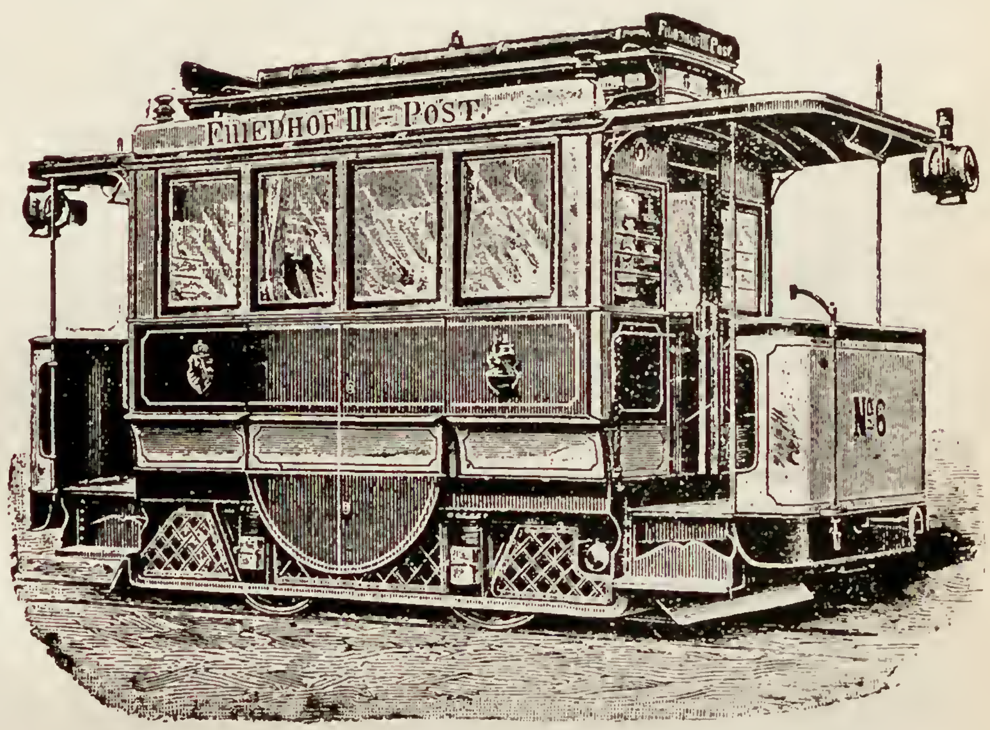
Previous to the delivery of the locomotive it was run a few trips on the New York Central Railroad on heavy fast passenger trains, and the accompanying indicator cards obtained.

THE GAS-MOTOR IN DRESDEN.

The gas-engine has been the subject of repeated experiments, both in this country and abroad, with the end in view of adapting it to tramway service. The great successes that have been achieved in using it in competition with steam have added a new incentive to its applications as a street-car motor. The consular reports issued by the State Department have contained a number of descriptions of such applications;* the latest of which comes from our Consul-General at Dresden Mr. William S. Carroll, which we reprint in full.

"About one year ago I witnessed a trial trip of a gas-motor car in this city, and since that time I have watched the progress and improvements that have been made, and am now able, with the aid of information obtained from Mr. John Young, Superintendent of the Gas Traction Company (Limited), London and Dresden, to report that the motor during the first trial trip worked fairly well, but showed some deficiencies, apparently in its mechanical construction, and that since that time those deficiencies have been remedied, and during later trial trips the motor car has proved entirely satisfactory.

"At the first trial the car always started with a noticeable jerk and did not run smoothly, and when not in motion a considerable quantity of gas was used to keep the motor running, causing the car to sway and tremble; the clutch coupling did not work regularly and broke easily; the car was clumsy and unsightly. All these objections have apparently been overcome, and an easy, manageable, economical motor for public traffic is the result.



THE DRESDEN GAS-MOTOR CAR SHOWING FLY-WHEEL DOORS CLOSED.

THE DRESDEN GAS-MOTOR CAR SHOWING FLY-WHEEL DOORS OPEN.

"The illustrations will show the appearance of the car.

"This car weighs 5½ German tons (about 12,127 English pounds). The distance between the wheels is 1.55 metres (about 5 ft. 2 in.), and the length of the car frame is 3.5 metres (about 11 ft. 5 in.). There are 14 inside seats, 10 on both platforms, and 12 on the top of the car, making a total capacity of 36 seats.

"The car has a gauge of 1.435 metres (about 4 ft. 7 in.), and has the appearance of an ordinary street-car, excepting the two folding doors in the centre of one side of the car, which cover the driving-wheel *S*.

"The illustration will show the working of the motor.

"The motor has 10 H.P., with two cylinders (C^1 and C^2), which are placed in line under one of the rows of seats, one on each side of the shaft.

"The gas in the machine is ignited by electricity without any noise. Two cylindrical gas tanks (B^1 and B^2) are fixed parallel with the axles of the wheels under the floor of the car; a third gas tank is placed lengthways under the row of

* See American Engineer and Railroad Journal for August, 1894, and October, 1894.

seats opposite the machinery, and serves as a proper balance to the car. These three gas tanks hold about 0.95 cubic metre (33.55 cub. ft.) of gas, and weigh about 250 kilogrammes (551 lbs). The water used in cooling the cylinders circulates automatically through copper tubes eight-tenths of a millimeter (0.0315 in) thick, which run from the top to the bottom of the car in a spiral shape. The water, when heated, rises to the top of these tubes, where it cools and then flows back into the gas cylinders. The tubes are concealed under the seats. The gas tanks are covered by plates. No part of the machinery is visible inside of the car. It is only accessible from the outside by opening the two large doors above mentioned and a number of smaller doors. The car, while in motion, is noiseless, and there is no odor from the gas.

" The driving-gear consists of four shafts. The motor-shaft *W* is driven directly by the gas motor, and transmits the motion by means of cogged wheels on the shaft *Z*. On this shaft there is a peculiar friction coupling, *R*, as shown in the cross-section view of the machinery.

" This friction coupling regulates the speed of the car by means of a reversing lever, *H*, connecting a larger or smaller spur-wheel, as may be desired, with the other parts of the machinery. Both wheel-axles are driven by chains and chain-wheels *K*, which run in oil, so as to use the entire adhesive weight of the car for the development of the tractive power. To diminish the friction, the bolts at the joints of these chains are incased in steel, which can revolve, and thus prevent any noise while the machine is working. During short stops the machine remains in motion. By means of a lever the machinery is thrown out of gear to stop the car ; while out of gear the motor uses very little gas, because the number of revolutions is diminished, and only after every 8 or 10 rotations a new ignition of the gas occurs, which is sufficient to keep the motor in motion. One of these levers is connected with the 'friction coupling,' and serves to diminish or increase the speed of the car from 150 to 240 rotations per minute ; the other lever is directly connected with the motor and controls the movement of the car forward or backward. The levers are easily controlled by the conductor.

" An alarm bell, similar to those used on ordinary horse-cars, is attached to the handle of the brake. The levers and brake-handles are easily removed from one platform to the other, as may be required when changing the direction of the car.

" The wheels of the car are peculiarly fastened to their axles. One wheel is secured to the axle, while the other can slip in its hub in the proportion of 80 per cent. of the circumference of the axle toward the neighboring wheel until it is necessarily taken along by the rotation of the axle. Thus, both wheels can revolve differently when the car takes a curve, and the friction or resistance caused by the curve is greatly diminished.

" The speed obtained at the trial trip was at the rate of 14 kilometres, or about 8.7 miles per hour. All curves were overcome with ease, and without any swaying or jerking motion, the smallest radius being 15 metres (49.2 ft.). The speed was diminished while passing over the curves.

" The consumption of gas amounted to about one-third of 1 cub metre (11.74 cub. ft.) per kilometre (0.621376 mile),* 1 cub. metre (35.316 cub. ft.) of gas costing 12 pfennigs (2.86 cents). The average cost of gas per kilometre, or 3,280 ft. 10 in., would be 0.04 pfennigs (0.95 cent).

" The gas used for the motor is under a pressure of 6 atmospheres, and the manometre shows at all times the amount of gas consumed.

" The compressed gas enters at first into a regulator for gas pressure (Pintsch system), where the pressure is reduced from 30 to 40 millimetres (1.18 to 1.57 in.) water pressure. The gas contained in the three gas tanks—viz., 0 95 cub. metre (33 35 cub. ft.) is sufficient to run the car 17.1 kilometres (10.63 miles).*

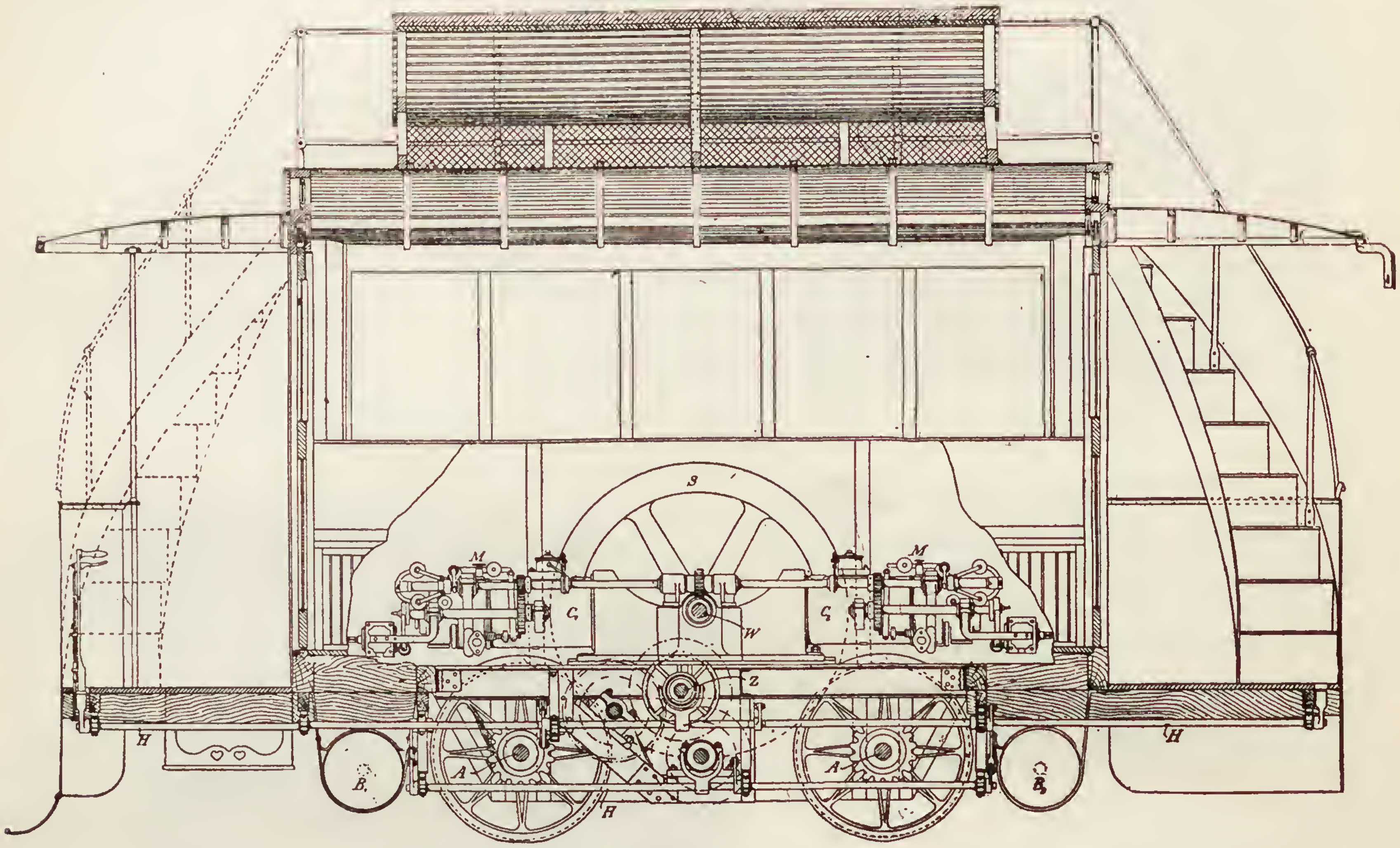
" The gas-supply station consists of an 8 H.P. gas motor, which runs a force pump with a capacity to compress about 60 cub. metres (2,118 cub. ft.) of gas to 8 to 10 atmospheres per hour. The gas is taken from the city gas-pipes in the street, and the tanks in the cars are filled by using rubber tubes or hose ; they can be filled in about thirty seconds.

" The cooling water must be removed from time to time, but not so often as the gas. This is done by means of water taps at the filling station. In extreme cold weather a little glycerine is used to prevent the water from freezing.

" It is estimated that a car like the one described can be built and fully equipped for about 15,000 marks ($3,570). This estimate is based upon the price of labor and materials in Germany and on the theory of manufacturing on a large scale.

" It is impossible now to fairly estimate the average life of a car or the annual expenses for repairs.

" This system of motor power is attracting wide attention, and many German cities are adopting it for street cars. Trials are proposed to be made with gas locomotives for narrow-gauge railroads and for shunting purposes at railroad stations."



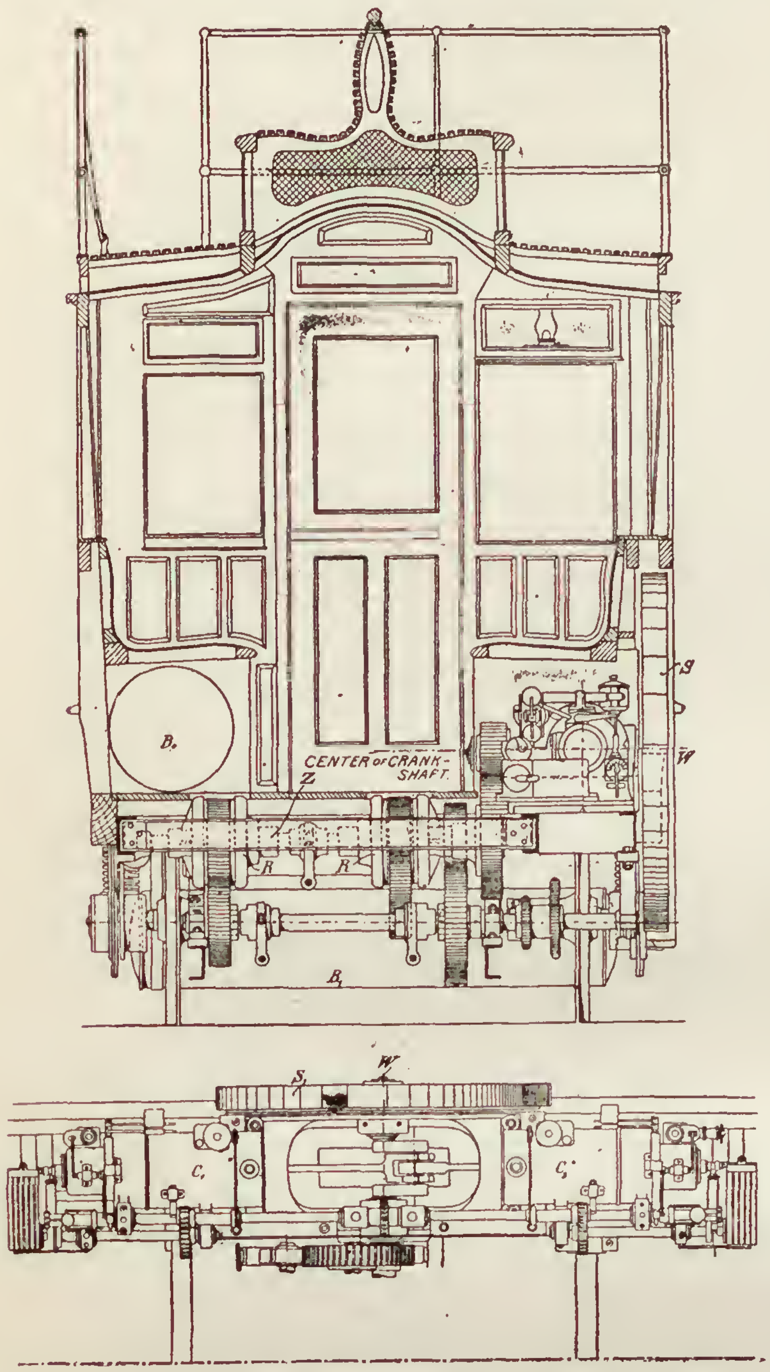
LONGITUDINAL SECTION OF THE DRESDEN GAS-MOTOR CAR.

* There is a wide difference between these estimates.

THE INTERNATIONAL RAILWAY CONGRESS.

A RECENT number of *The Engineer* contains the following outline of the proceedings of the Congress, which began its session on June 26 :

The fifth session of the International Railway Congress will be held this year in London. The meetings will take place in the Imperial Institute buildings, which will thus for once be used to some purpose. The Railway Congress was established a little more than four years ago. Its object is the acquisition and diffusion of information on all matters con-



CROSS-SECTIONS OF THE DRESDEN GAS-MOTOR CAR.

nected, even somewhat remotely, with railways. The number of members is not stated ; and, indeed, it may be taken for granted that all railway men are, in an *ex-officio* sense, members. Those who attend the meetings of the Congress are known as "delegates," and the magnitude and importance of the forthcoming meeting may be realized when we say that 800 delegates are expected to attend. Of these, 600 will come from the United States, South America, Canada, Australia, New Zealand, France, Germany, Belgium, Russia, and Italy, to say nothing of less considerable countries. The remaining 200 represent the railways of the United Kingdom. The business of the Congress is transacted on somewhat exceptional lines. Papers or reports, or answers to questions, are printed and circulated among the members during the year, the Congress having an official organ of its own, the *Congress Bulletin*, in which various languages are used as occasion demands. The separate reports are reprinted from the *Bulletin* and circulated. One lying before us may be taken as a specimen It refers to a question—No. XV.—concerning the twenty-four hours' day, which question is thus summarized : "Introduction in time tables of continuous reckoning from one to twenty-four hours, and of the division of the hour into 100 parts ; present state of the question ; practical adoption in different countries ; advantages to the public and to the railway service ; would the alteration of existing clocks be necessary, and if so, how could it best be accomplished ?" The report is by MM. Scolari and Rocca. They discuss the whole question elaborately, and arrive at a conclusion in favor of the twenty-four hours' system, which is not remarkable seeing that they are Italians, and that the system has been in force in Italy for centuries. None of the papers or reports will be read at the forthcoming meeting, not even the summaries prepared in most cases by the authors. On the first day only official business will be transacted. The meeting will be broken up into sections, each with its chairman or president, and on subsequent days the reports and papers will be discussed by the various sections ; but the conclusions and recommendations at which they arrive, and which they frame, must be submitted to the whole body of delegates before they can be regarded as satisfactory or sanctioned by the Congress. Thus it will be seen that in certain respects the arrangements are very similar to those of the British Association meetings. It is impossible at present to say which reports will be brought forward for discussion, but the number is considerable, and the proceedings are certain to be of interest. Each day a little journal will be published and circulated among the delegates, supplying them with information which could in no other way or with so little loss of time be imparted.

The whole time of the delegates will not be spent in discussing papers and reports. Visits will be paid to places of interest, and excursions will be made to various parts of the kingdom. The accompanying programme, which has been brought down to date, will convey to our readers the most recent information. The offices of the Congress are at 29, Abingdon Street, Westminster. Mr. Acworth is the Secretary. We believe that no qualifications will be required by those wishing to attend the meeting, save the fact that they are in some way connected with railways and their working, and so have a real interest in the proceedings.

The Congress will be opened ceremoniously by the Prince of Wales, on Wednesday, June 26, at 3 P.M., and at 10.30 P.M. there will be a reception by Mr. Bryce, the President of the Board of Trade. The remainder of the week will be devoted to excursions into Lancashire and elsewhere. On Monday, July 1, the serious business of the meeting will begin. On Tuesday evening there will be a grand banquet given at the Imperial Institute by the Railway Companies Association. On Wednesday morning there will be sectional as well as general meetings, and in the afternoon excursions to points of railway interest in or near London. Thursday and Friday will be devoted to business, and on Saturday there will be a pleasure excursion to Brighton, so that foreign delegates may escape from London on Sunday. On Monday, July 8, more business, and in the evening a banquet at the Crystal Palace. On Tuesday the Congress will be wound up, the closing ceremony will take place, and large numbers of the delegates will start for Scotland to see the Forth Bridge, to Ireland, and other parts of the United Kingdom. It will be readily understood that the delegates will not be idle, to say nothing of the Secretary and other officers, whose duties will be singularly arduous.

The great railway companies have prepared a special programme of excursions for June 27, 28, and 29.

The following is an abstract of the official list of subjects for the meeting of 1895 :

SECTION 1. PERMANENT WAY AND WORKS.

1. *Strengthening Track in View of the Increased Speed of Trains.*—Type of track, section of rail and quality of steel, including comparison of soft and hard steel. Rail joints, ties and ballast.

2. *Special Places in Track.*—Means to avoid the necessity of express trains slackening speed, and to prevent shocks in passing sharp curves, long and heavy grades, split switches, track and road crossings at grade, drawbridges, etc.

3. *Junctions.*—Best arrangement on main lines to avoid having to slacken speed, and the best means of maintaining speed with safety while abandoning superelevation on the junction curves.

4. *Construction and Tests of Metal Bridges.*—Specifications and requirements for grade of metal. Methods of original and periodical testing of bridges, and can such methods be regarded as of practical value in settling the actual state of repair and margin of safety ?

SECTION 2. LOCOMOTIVE AND ROLLING STOCK.

5. *Boilers, Fire boxes and Tubes.*—Steel boilers and fire-boxes. Purification of feed-water. Experiments as to the production

of steam—viz., results obtained with tubes of different dimensions, material, and spacing; influence of smoke-box capacity and form of smoke-stack, spark arrester and exhaust-pipe, and the influence of speed on the production of steam.

6. *Express Locomotives.*—The type of engine and the use of high pressure and compound system. Steam distribution and balanced slide-valves. Locomotive construction (simple and compound) from the point of view of diminishing the strains on the track.

7. *Rolling Stock of Express Trains.*—Cars for express trains and long journeys. Vestibuled trains. Improvements in interior arrangements, and in car heating and lighting.

8. *Electric Traction.*

SECTION 3. TRAFFIC.

9. *Acceleration of Freight Traffic.*—Influence of speed upon the expenses of hauling, the utilization of cars, the number of cars, and the accommodation and plant required.

10. *Station Working.*—Methods of accelerating the switching of cars and handling of freight. Sorting yards. The employment of mechanical and electrical appliances in switching and in making up trains.

11. *Signals.*—Improvements and economy in block and interlocking plants. Signals in tunnels. Form instead of color signals to avoid dangers from color blindness or defective sight. Methods of preventing collisions at dangerous points on express lines in case of trains passing signals at danger.

12. *Cartage and Delivery.*—The collection and delivery of freight.

SECTION 4. GENERAL.

13. *Organization.*—Central administration and executive and outdoor staff.

14. *Settlement of Disputes.*—This refers to disputes between railways as to freight traffic.

15. *Twenty-four-Hour Notation.*—Introduction of time tables reckoning time from one to twenty-four hours. Division of the hour into 100 parts. Alteration of clocks. Present status of the question.

16. *Decimal System.*—The general adaptation of the decimal system in calculations and accounts, and the general introduction of the metric system.

SECTION 5. LIGHT RAILWAYS.

17. *Contributive Traffic.*—A method for main railways to encourage the building of working of light feeder lines. In the case of light railways what relaxations can be made by the government in its standard requirements of construction or working without risking the public safety.

18. *Leasing Light Railways.*—The system of working light railways by leasing companies, and the terms of leases, with the practical results.

19. *Light Railway Shops.*—Should the principal shops be at the middle or one end of the line?

20. *Brakes for Light Railways.*

Several delegations of railroad men from this country have sailed for Europe during the past month to attend the congress which was opened on June 26, and which promises to be a very interesting and profitable meeting. The three days following the opening ceremonies will be devoted to the inspection of English railways, and a very enticing programme is offered to those who will be there.

An exhibition of English railway appliances is now and will remain open during the session of the congress. This exhibition is described in *The Engineer* of June 7 as follows:

"The exhibition of railway appliances was opened on the 1st instant. It is a very small affair, contained in a corrugated iron shed in one of the yards of the Imperial Institute, with an overflow of certain exhibits into otherwise unused whitewashed passages below the level of the street. Why an exhibition of the kind should have been held at all in Kensington would have been an inscrutable mystery did we not know that the Railway Congress is to meet in the Imperial Institute, and no doubt it has been concluded that many of, if not all, the 800 delegates will find their way into the exhibition. There are in all 90 stands, none of which bear a number as yet; and a great many of these stands are occupied by models, for the most part by more or less amateur inventors of electric railway signals, detonator setters and such like. The most important exhibits are no doubt those of such firms as Saxby & Farmer, Siemens Brothers, Dalton & Co., the Gloucester Carriage & Wagon Company, and others well known in the railway world. There are some things shown which excite mild surprise; for example, we have the old automatic brake, a development of an idea born in the days when the *Rocket* yet ran. The weight of the wagon applies a brake, and the pull of the engine takes it off. The fundamental theory of such a brake is all wrong, because the engine could not run with steam off, and the brake would go on, whether it was wanted or not, on an incline. Then there are automatic couplers exhibited. These appear to be superfluities, seeing that there is reason to believe that there are now running in the United States 7,000 distinct patents for couplers, and that the number is being augmented at the rate of about four per week, with occasional spurts of eight or ten.

"In a succeeding impression we shall describe those exhibits which deserve special notice. For the moment we content ourselves with mentioning a few of the more noteworthy exhibits. First among these may be placed West's patent tire-setting machine. The principle is that when steel or iron is compressed beyond the elastic limit it takes a permanent set. The tire to be secured is submitted to a tremendous radial pressure, and as a result it is shortened and grips the wheel. The machine exhibited consists of a strong weldless steel ring, inside of which are disposed 18 hydraulic presses with rams 8 in. in diameter, and a very short stroke. The heads of these rams carry curved pieces precisely like brake blocks. The wheel to be hooped—when we saw the machine a hickory carriage wheel was in the press—is a very slack fit in the tire; the press is brought to bear, and as the pressure is half a ton to the square inch, each press exerts 25 tons, or the whole 18 presses 450 tons. This has to be endured by a tire 2 in. $\times$ ½ in. The result is that it is shortened permanently by as much as an inch, and fits the wheel perfectly. One of these machines has been at work now for some time in the gun-carriage department at Woolwich. This is a very curious and original process well worth seeing. The press is in action at the exhibition every day at noon and at four P.M. Messrs. Siemens Brothers have a nice display of electrical apparatus, and a railway wheel and axle fitted with Meneely's tubular roller bearing. The Patent Shaft & Axletree Company shows nothing very novel, but the stand will well repay a visit. Messrs. Saxby & Farmer have a full-size signalling apparatus, showing the union of the lock and block systems, a notice of which we must defer. The Gloucester Carriage & Wagon Company shows two handsome railway carriages, one for light railways, to carry 30 passengers, which seem to be specially designed.

"There are a multitude of carriage locks, improved windows, ventilators, mats, carriage upholstery fittings, lamps and other matter of the same character. But none of these things call for special remark at this moment."

Copies of a number of the reports to be presented have reached us, and among them are the following:

STRENGTHENING OF PERMANENT WAY IN VIEW OF INCREASED SPEED OF TRAINS.

By William Hunt, Chief Engineer of the Lancashire & Yorkshire Railway, Manchester. The report consists of a summary of replies received from 13 railways in England and Wales, 4 in Scotland, 2 in Ireland, 6 in America, 1 in India, and 1 in Australia to a circular of inquiry covering the following points:

Type of permanent way suited for lines traversed by trains at high speed. Gradual strengthening of existing roads, so as to permit of an increase in the speed of trains.

A. Section of rail. Calculation of the strains trains imposed by the rolling load. Results of experiments.

B. Mode of manufacture and nature of rail metal. Comparison of soft with hard steel. Steel produced (1) by the acid process in the Bessemer converter; (2) by the basic process in the converter; (3) by either process in the Martin furnace.

C. Rail connections. Fatigue of fish plates. Construction of joint best calculated to secure uniform strength of the road throughout. Rails laid in chairs, and Vignole's rails.

D. Sleepers: their quality, dimensions and distance apart.

E. Ballast: the various descriptions and methods of laying.

There is nothing especially new or interesting in the report. We are told what is generally known—that in the United Kingdom bull-headed steel rails are almost universally used, and in this country flat-bottomed rails. In England the weight of rails varies from 80 to 82 lbs. per yard; in Scotland, from 77 to 90 lbs.; in Ireland, from 74 to 85 lbs. The length of rails adopted by English companies is generally 30 ft. The Great Western Company's rails are 32 ft. long, and the London & Northwestern are adopting a length of 60 ft. Most of the companies subject the rails to a test by a falling weight. Some test the rails as girders, suspending dead weights from

the centre and specifying the deflection. Chemical tests are not generally used. The breaking weight in tons per square inch is specified by five companies. Elaborate tables containing the details of the replies to the circular of inquiry and 35 pages of illustration accompany the report.

PLACES IN PERMANENT WAY REQUIRING SPECIAL ATTENTION.

By M. Sabouret, Ingénieur des Ponts et Chaussées, Principal Permanent Way Engineer of the Paris-Orleans Railway Company. This report, of 19 pages, relates to "means to avoid the necessity of expresses slacking speed and to prevent shocks in passing special points, such as sharp curves, long and steep gradients, facing points, rail crossings, road crossings, swing bridges, etc."

BOILERS, FIRE-BOXES AND TUBES.

By Ed. Sauvage, Chief Engineer of Mines, Assistant Locomotive Superintendent of the Eastern Railway of France.

M. Sauvage's report, of 74 pages, resembles similar reports made to our Master Mechanics' Association. It relates to the following points:

A. Steel boilers and fire-boxes. Strain to which they are subjected in use and conditions on which the plates are accepted.

B. Iron tubes. Means of preventing leakage in the tube-plates.

C. Injurious effects of the feed-water on the boilers and tubes. System of purifying.

D. Synopsis of experiments as to the production of steam.

The latter relate to the experiments carried out by the Paris-Lyons-Mediterranean Company, under the direction of the late Mr. A. Henry, a report of which has been published in the AMERICAN ENGINEER. M. Sauvage's report gives a large number of illustrations of boilers used on various roads in Europe and this country, and shows some of the details of their construction. He also gives illustrations and descriptions of different methods of fastening tubes and of various forms of spark arresters and blast pipes. The following are his conclusions:

"1. The use of mild steel for the boiler plates of locomotives has become a matter of current practice; this use being mainly justified by the quality of the plates, which is much more uniform than in iron. Particularly in the flanged portions of the work steel is more readily worked.

"2. Steel plates for boilers should be very mild, and characterized by a breaking strain not exceeding 28½ tons per square inch, and preferably between 25½ and 22 tons per square inch. The plates will be made from open-hearth steel, and no pig containing phosphorus should be used in their manufacture.

"3. The substitution of steel for iron allows at times of a slight increase of pressure in the boilers without any modification in thickness of plate.

"4. The working up of steel plates does not require any extraordinary precautions; they can stand local application of heat, notably for the drawing out of the corners. A wise precaution is to anneal the plates after working them prior to riveting; nevertheless, this precaution is not indispensable when experience has proved the good quality of the plates and the merit of the boiler-maker's work.

"5. Steel fire-boxes continue to be practically unused in Europe; the few cases in which they have been experimented with do not show that they have any advantage over the copper box, at least with the qualities of steel available in Europe. This opinion does not apply to small locomotives whose work is not of a very hard nature; for these, steel fire-boxes may be advantageously used.

"6. Iron and steel boiler tubes have come more and more into use; they can be substituted for brass without disadvantage, the substitution actually resulting in a considerable economy.

"7. Iron tubes do not require copper ends.

"8. The tubes are generally expanded with a dudgeon expander, the holes in the tube plates being slightly coned or even cylindrical.

"9. The beading of the ends of the tubes is not indispensable.

"10. Ferrules are only necessary at the fire-box, and then only when the tubes show signs of leakage.

"11. In general it may be said that the avoidance of leakage in the tubes depends mainly upon the care taken in the working of the locomotives; it may be safely said that locomotives, the tubes of which are fixed in the ordinary way, do not give any trouble if the fire is attended to in a regular manner, without abnormal entry of cold air into the box, and if care is taken to allow the boiler to cool off before being emptied, and more particularly before washing out with cold water. It is unwise to draw fires before an engine has been shedded, as the blast in this case draws a considerable volume of air through the fire-box and the tubes.

"12. Disincrustants may be found useful to obviate the formation of adhesive deposits; but their nature and proportions should be adapted to varying local conditions.

"13. The purification of feed-waters which contain much carbonate of lime, and particularly of selenitical waters, prior to their being used, is extremely desirable. The provision of plant for this purpose necessitates a heavy initial outlay; but the capital thus expended will often be recovered through economies of fuel, cost of washing out, and maintenance.

"14. The delivery of the feed-water into the steam space in such a manner that the steam quickly ejects from the boiler the air drawn in with the water, and that any local cooling of the plates be avoided, is worth a trial.

"15. It is not usually advisable to exceed a length of from 13 to 14¾ ft. for boiler tubes.

"16. The flue space should be as large as possible, which justifies the suppression of ferrules. The diameter of the tubes should not be too small nor should they be placed too close together. As far as possible it is advantageous that their internal diameters should be from 1½ to 2 in., and their distance apart not less than 0.709 in.

"17. Ribbed tubes with an external diameter of from 2.36 to 2.75 in. are suitable for locomotives when the tubes are short. It may be found advantageous to substitute them for ordinary tubes of 2 in. diameter, with the same small diameter by suitably reducing the size of the ribs.

"18. The comparative effect between placing the tubes in checkerwise or quincunx rows as against vertical rows is not apparent; the preference, is, however, generally given to the latter arrangement.

"19. The nature of the metal in the tubes does not in any way affect the production of steam.

"20. The influence of varying the capacity of the smoke-box is inappreciable. Extension smoke boxes of American type, which have been tried by many European administrations, do not seem to give any better results than the ordinary smoke-box. It therefore appears advisable to retain the use of the latter arrangement.

"21. No evident superiority can be assigned to any particular form of chimney; those which are slightly conical in shape (of small diameter at the lower end) appear to be favored. It is advisable to prolong the chimney toward the interior of the smoke-box, giving this extension the form of a cone; the nozzle of the blast pipe should not be in this case much higher than the top row of tubes.

"22. No form of spark arrester can be said to offer advantages. All obstruct the draft without being absolutely efficacious; the ordinary spark arrester, made of wire, suffices in most cases.

"23. In the different systems of regulating the blast, the annular disposition appears to be slightly the best; it, however, becomes sometimes a little complicated if a variable section for the blast-pipe, though otherwise desirable, is adopted.

"24. All exhausting through single blast-pipes should be variable. The variation should not, however, be carried to such a point as to abnormally reduce the blast-pipe section; it is doubtless the lack of a suitable limit which has brought the use of variable blast into disrepute as being either injurious or useless. A simple mechanism with two controllable valves appears quite suitable.

"25. Attention may be recalled to the rule mentioned in paragraph 21 as to the height of blast-pipe; it should not be much higher than the upper row of tubes, even if the chimney is not extended into the smoke-box.

"26. Speed has no noticeable effect upon the production of steam; in other words, with equal weights of steam exhausted per second, and the same pressure in the cylinders at the start of the pre-exhaust, the greater or less frequency of the exhaust impulses is a matter of indifference. This fact is clearly proved by the action in service of two-cylinder compound engines."

EXPRESS LOCOMOTIVES.

By John A. F. Aspinall, Chief Mechanical Engineer of the Lancashire & Yorkshire Railway.

Mr. Aspinall has contributed a very elaborate report of 197 pages covering the following points:

A. Type of engine most suitable for high speeds.

B. The use of high pressure, and application of the compound principle.

C. Improvements in distribution, and balanced slide-valves.

D. Engine building regarded from the point of view of

diminishing the strain on the permanent way. The effect from this point of view of the compound principle.

E. Description of individual express engines.

This report is so long that we can only refer briefly to some of its principal features. For light trains and on roads with easy grades the author advocates engines with a single pair of driving-wheels, but for heavier grades and trains he says two pairs of coupled wheels are needed. "The maximum capacity of the locomotive boiler," he says, "is nearly reached. In America and in the continent, engines with much larger boilers can be constructed than in England, owing to the greater limits of the bridges and platforms in the respective countries." He gives some very interesting data with reference to the working of compound locomotives on the North Eastern Railway, which was furnished by Mr. Wilson Worsdell, the Locomotive Superintendent of that line. This data the author summarizes as follows: "The statement shows that 447 non-compound engines ran 14,807,261 miles with a coal consumption of 4,829,040 cwts., giving an average of 36.52 lbs. per mile; and that 395 compound engines ran 13,799,482 miles with a coal consumption of 4,122,239 cwts., giving an average of 33.45 lbs., or a saving of 8.40 per cent." No figures are given with reference to the loads hauled, but the results have been tabulated, and show that the maximum average saving in express passenger service in each of three years was 6.5, and the minimum 2 per cent. The maximum in "goods" service was 23.8, and the minimum 0.0. A report of the performance of Mr. Webb's compound express engine *Greater Britain*, which has already been published, is also given, with a report of an experimental trip with this same engine from Crewe to London, in which, with a train 3.96 times as heavy as the engine and tender, and with average speeds of 41.18 and 44.59 miles per hour, the consumption of coal was 1.719 oz. per mile per ton of train, including engine and tender. It may be remembered that the consumption by engine No. 999, as reported by Mr. Buchanan, in one test was 1.644 oz. Mr. Aspinall reports further that "on the Irish railways compounds have been experimented with by the Great Southern & Western Railway Company, also by the Belfast & Northern Counties Railway Company, and on the latter railway several compounds have been at work for some time with very favorable results. They have two cylinders, the Worsdell form of starting valve, and the Walschaert valve gear. The fuel used by these engines was South Wales coal, and the consumption showed an advantage varying from 11.17 per cent. to 17.74 per cent. . . . The working pressure was 170 lbs." Continuing on this subject in the report, it is said that "the highest boiler pressure recorded is that shown by the Paris, Lyons & Mediterranean Company, 219.9 lbs. per square inch; the North & Southern Railways of France having 198.6 lbs. per square inch.

"To obtain the best possible results from a compound engine, it has been found by experience that the high-pressure cylinder should be made at least 1 in. larger in diameter than one of the cylinders of a simple engine having the same power. At the same time the boiler pressure must be increased from 20 to 30 lbs. per square inch; and Mr. Worsdell, in his latest compound engine, No. 55, has gone still further and introduced 40 lbs. per square inch more than that used on the simple engines, No. 9, working in the same link. The total pressure of the compound is 200 lbs. per square inch, which is the maximum in this country, exceeding the American, and following very closely upon the French practice. This increase of pressure has also become necessary owing to the extra length and sinuous nature of the steam passages, and to overcome the resistance in the receiver. It must be remembered that the final pressure of the blast of a simple engine is of great importance, and also that in the compound the number of beats is reduced 50 per cent.; consequently, if the exhaust pressure is too low the efficiency of the boiler is reduced. By the adoption of high pressure the boiler and all steam joints must be made proportionately stronger, also lubricants having high flash points become necessary and the gland packing constructed to withstand the extra temperature. The latter point is not now of such serious importance, as the excellent systems of metallic gland packing which modern practice has introduced enable engines to run for even 12 months without repacking.

"From the foregoing statements it appears that a large and varying amount of fuel economy has been attained by the compound system, and the question now arises, Will it cover a reasonable interest on the extra first cost and repairs? In the matter of first cost it is probable that the high pressure will cause a corresponding increase in expenditure for boiler power. Excluding the latter, and when compounding is carried out by the aid of two cylinders, the expenditure should not be excessive, but when obtained by the application of three or more it may be expected to be greater. The simple engine is the product of years of accumulated experience, and, therefore, has this great advantage over the compound; but it is well known that the heavy repairs are carried out in the fire-box and boiler—the mechanism of the engine requiring the least attention. In compounding, higher pressures are required, therefore more frequent boiler repairs will be the outcome; but with regard to the other parts of the engine, they should not be excessive, and even those failures which have occurred may be attributed to untried designs. The general impression is that compounds are more economical in slow than fast running, which may be attributed to insufficient areas of the exhaust passages and the sluggish action of low-pressure steam. On the face of this it would appear strange that in this country there are more passenger than goods compounds, which is due to greater attention being devoted to the passenger engine, owing to the increased demands of the public. The principle has made less progress in this country than it has abroad, perhaps because it has a most formidable predecessor in the English simple engine, which is so economical and satisfactory in most respects. Undoubtedly the strongest argument in its favor points to its almost exclusive use in those countries where fuel is much more expensive than in England. On the continent and in America it appears to be gaining favor, if numbers are an indication; and the success of the Wordsell von Borries engines, as indicated by the Official Return of Consumption of Fuel on the Northeastern Railway and the continued and extended use of the Webb system on the London & Northwestern Railway, are strong points in favor of the system."

A very interesting table is given in which the ratio of heating surface to cylinder area and cylinder capacity, weight per H.P. of engine, etc., has been calculated for four-wheels-coupled engines on 45 different roads. This data is given under the following heads:

Area of two cylinders.*

Capacity of two cylinders.

Total heating surface to cylinder area—square feet to square inches.

Total heating surface to cylinder capacity—square feet to cubic inches.

Fire-box heating surface to tube heating surfaces.

Grate area to total heating surface.

Tractive force in pounds.

Tractive force to weight on driving-wheels.

H.P. at 15 miles per hour.†

Weight per H.P. of engine and tender in pounds.

It is to be regretted that the cylinder capacity for each foot or inch in the circumference of the driving-wheels and for each ton of adhesive weight was not calculated, because then the figures would have been comparable. As given in the table they are not. The heating surface per ton of adhesive weight would also have been more indicative of the relative proportions of the engines than the figures as they are now. Other similar tables are given, showing the proportions of six-wheels-coupled, single driving-wheel and compound engines.

A very elaborate series of tables giving the principal dimensions of 67 different engines on roads in all parts of the world will be very valuable for reference. Diagrammatic views and brief descriptions of the engines and the service in which they are employed add to the usefulness and interest of the report. These are followed by diagrammatic views of the trains hauled by the different engines, the weight of trains and profiles of the roads on which they are used. The report closes with a series of reproductions of engravings of locomotives, most of which have been published in English and other engineering papers.

The report contains an immense amount of data, but the reader will lay it down with a little disappointment that no more definite conclusions are reached; but perhaps they will be in order after the report has been discussed.

Station Working.

By George H. Turner, General Manager of the Midland Railway.

This report covers the following points:

A. Methods of accelerating the shunting of trucks and handling of merchandise. Arrangements of sorting sidings.

B. Employment of mechanical and electrical appliances in shunting and marshalling.

The report consists largely of a description of the methods employed in the Midland and other lines for handling traffic. The report is illustrated by engravings made from photographs, showing the way in which "wagons" are coupled on

* The area of the pistons is what is given.

† The tractive force and H.P. are worked out with the mean effective steam pressure in cylinders taken at 70 per cent. of boiler pressure.

English roads, several views of stations, and a number of plans of stations showing the arrangement of tracks, buildings, etc. Most of the methods and appliances described would be inapplicable to American roads. The arrangement, however, of what is called a "fan" of sidings for assorting wagons might, however, be studied with advantage by American railroad men.

SIGNALS.

Recent improvements in block and interlocking apparatus, chiefly from the point of view of economy in initial outlay. Signals in tunnels. Methods of preventing collisions at points of danger on express lines in case of overrunning stop signals. Replacement of color signals by geometric form signals, in order to avoid the dangers arising from color blindness or defective vision.

By A. M. Thompson, Signal Engineer of the London & Northwestern Railway.

This report consists chiefly of summaries of replies to 75 questions relating to signals, which were sent to various railways. These replies are, for convenience, arranged in a tabular form in an appendix. Information is also given with reference to the British Board of Trade requirements and the railway commissioners of New South Wales. In a note by H. Raynor Wilson, Signal Assistant to Engineer of the Lancashire & Yorkshire Railway, the advantages and disadvantages of lock and block on a busy line of railway are set forth, and a list of accidents, reported by the Board of Trade, are given, which the writer says would have been prevented if the lock and block system had been in use.

ORGANIZATION.

Organization of the central administrative and out-door staff on the various systems of different countries.

Two reports on this subject have been received, one of 260 pages, by G. Duca, General Manager of the Roumanian State Railways, and another of 23 pages by Frederick Harrison, General Manager of the London & Northwestern Railway.

In the first report the author has passed in review the systems of organization existence in continental countries of Europe, and the bulk of this portion of the report—219 pages—will indicate how minutely this has been done. In a few pages at the end he summarizes his "general considerations."

Mr. Harrison, in his report, deals with the subject under two heads as follows:

1. The railways of the United Kingdom of Great Britain and Ireland.
2. The railways of other English-speaking countries.

In drawing his conclusions he says:

"In the United Kingdom the directors delegate their powers for executive purposes directly to certain responsible officers, whereas in the United States the directors appoint a president and vice-presidents, and the president appoints the executive officers. The president appears to have somewhat larger powers than any single functionary on the railways of the United Kingdom; but this is, after all, a matter of detail, and does not vitiate the general principle. . . .

"In conclusion, I desire to observe that although organization on sound principles is necessary for the proper administration of a railway, as of any other undertaking, it is essential to the successful management of railways that it should enter thoroughly into detail. For this purpose a high standard of efficiency of the staff is the most important consideration. The rank and file must be carefully trained not only to carry out the duties allotted to each, but so as to develop their energies and intelligence; the strict maintenance of discipline and insistence on efficient work by subordinates of all grades, whether in carrying out instructions, the exercise of supervision, or the intelligent care of interests intrusted to them, and the utilization of the training experience and best intelligence of the staff, should be part of the responsibility of the heads of departments and chief officers. . . ."

THE TWENTY-FOUR HOUR DAY.

Introduction in the time-tables of continuous reckoning from 1 to 24 hours, and of the division of the hour into 100 parts. Present state of the question. Partial adoption in different countries. Advantages to the public and to the railway service. Would the alteration of existing clocks be necessary, and if so, how could it best be accomplished?

By Mr. Scolari and Mr. Rocca, Chief Inspector and Inspector of General Management of the Mediterranean Railways of Italy.

The following topics are discussed in this report: History in brief; decimal division of time; the 24-hour notation; advantages of the 24-hour notation; objections to the 24-hour notation; the method expressing midnight; methods of applying the change; bibliography.

DECIMAL SYSTEM.

General adoption of the decimal system into calculations relating to the construction and working of railways.

Method of facilitating the introduction of the metric system of weights and measures in those countries where it is not already in use.

By I. L. Wilkinson, Chief Goods Manager of the Great Western Railway.

The writer, in his report, concludes that he does not see the way at present to recommend the adoption of a decimal system for the domestic business of the railways in England, but "sees no great difficulty in the arrangement of a standard of exchange for moneys, and in fixing equivalent values for weights and measures, to be used conjointly with the local bases of values of the various countries interested in the proceedings of the International Railway Congress."

LIGHT RAILWAY SHOPS.

Should the principal shops be in the middle or at one end of the line?

By Mr. Ferzi, General Manager of the Suzzara-Ferrara Railway.

The author draws the following somewhat colorless conclusions:

"The position of the principal shops of a light line cannot be fixed according to any general rule, because local circumstances greatly influence the choice.

"Apart from the advisability of placing the shops at the end or at an intermediate point of the line, it must be admitted that it is always preferable to build them at the station which, owing to passenger and goods traffic, is the most important, either because it is just at that point that it is necessary to keep the largest number of engines for shunting and strengthening trains and for use on specials, etc., or because it is much easier to establish repairing shops, find the necessary hands, and procure materials and insure the general superintendence of the service there.

"Still, no fixed rule can be laid down; and only by a most careful investigation of the circumstances involved in working a line and by calculating the advantages presented by one site over another will it be possible to decide upon the most convenient site on which to establish the sheds in any given case."

The discussions at this congress ought to be of very great interest, although, from the programme of proceedings, it now seems as though it, like all similar assemblages, will suffer from too much and too many entertainments. Excursions to various parts of England have been arranged, dinners are to be given, and when all these have received due attention there may not be much time left for anything else.

THE CONVENTION OF THE AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

THE twenty-eighth annual meeting of this Association was opened at Alexandria Bay, N. Y., at 9.15 o'clock on the morning of June 17, with President Garstang in the chair.

In his address the President placed particular stress upon the importance of forming a closer relationship between the employer and the employé as a preventitive of strikes, and suggested profit-sharing as a means toward that end.

The first report presented was that of fire kindlers, of which we present an abstract.

FIRE-KINDLERS.

This Committee reported fully a year ago on the devices for kindling fires that were then in use, but a resolution was passed continuing the Committee for another year, and asking that they gather all of the information possible on the subject. Little or no change has been made in oil-kindling devices, but a large number of experimental devices have been tried; but, as a rule, without marked success. The plan of introducing the oil-fire under the grates was tried with the belief that this was the proper place to light the coal. Heavy loss was caused by radiation from the ashpan, and the fire was not kindled as well as when the fire was applied above the fuel. Oiled waste has been tried, and independent kindlers, using a can of oil flowing by gravity to the kindler; but such devices are cumbersome, require more labor to handle, and increase the fire risks.

The cost of compressed air has never been charged to oil-kindler expenses, and we think that it need not be for purposes of comparison with wood, for the reason that there are expenses in handling wood fuel, not charged against it as fuel, that more than compensate for the cost of compressed air. By experiment it was found that a standard main air

reservoir containing 15,800 cub. in. of air at 70 lbs. pressure kindled three fires in ordinary eight-wheelers, using about 300 lbs. of fuel each ; this goes to show that the amount used is not excessive.

The officials of the Baltimore & Ohio, the Chicago, Rock Island & Pacific, the Wisconsin Central, the Burlington, Cedar Rapids & Northern, and the Minneapolis & St. Louis have made numerous experiments to determine the efficiency in time and cost of kindling fires with oil and wood under all kinds of conditions.

Both the Chicago, Rock Island & Pacific and the Burlington, Cedar Rapids & Northern furnish reports by months, showing the actual number of fires kindled for a year, with amount of oil used per fire and the cost of the same. These records, covering, as they do, a full year (61,768 fires), all kinds of weather, all kinds of locomotives, the fluctuations of oil prices, etc., can be taken as pretty correct, and they show that the cost of kindling locomotive fires by oil is less than 2 cents per fire.

Of the several devices tried, only one has come into anything like extended use. The Leslie kindler is in use in 407 stalls, and in course of installation in 428 more. All of the tests referred to were made with this device.

The Smith kindler is in use on the Illinois Central, but we have been unable to get any data as to its work, other than that it is doing well.

That the oil-kindler is past the experimental stage seems proven. There is no doubt of its efficiency. It saves labor and time, reduces fire risks, reduces hauling of fuel for kindling and storing and handling. Its cost—about $20 per stall—is easily saved in a year in economy over wood.

The Le Bel kindler is in use on the Canadian Pacific, the Fitchburg, and the Vermont Central. It is made up in the form of bricketts, 6 in. long by 2 in. wide and 1½ in. thick. It is composed principally of rosin, fuel oil, and sawdust. From four to 10 pieces are used to light a fire, the smaller number being enough for ordinary eight-wheeled engines. This kindler costs between 1 and 2 cents per stick ; comes in boxes of 100, and, of course, requires no plant. Being inflammable, it should not be stored in buildings on account of fire risks.

The following is one of a number of tests made on the Chicago, Rock Island & Pacific Railway to ascertain the difference in time in getting up 50 or 60 lbs. of steam, using the Leslie kindler and dry hard wood on the respective engines, with the blower used on both engines equally :

Standard Passenger Engine No. 936.			Standard Passenger Engine No. 937.		
Steam.	Hour.	Minutes.	Steam.	Hour.	Minutes.
10	..	48	10	..	55
50	1	36	50	1	48
With Blower.			With Blower.		
Temperature of water....68°			Temperature of water....68°		
Coal used................454 lbs.			Coal used................454 lbs.		
Oil used...............1½ galls.			Wood used............⅛ cord, dry hard.		
Cost......................2.56 cents			Cost....................33 cents.		

The above test may be taken as typical of a number that are given in detail in the Committee's report, all of which go to show that the Leslie kindler is an exceedingly economical and efficient device. In another test made on the Chicago, Rock Island & Pacific Railway, a comparison of the amount of steam raised by oil and wood was obtained. Two standard passenger engines were washed out and filled with two gauges of water, and fired with an equal number of pounds of coal, one with one-eighth cord of wood, and the other with 1½ galls. of oil. The one using wood and 454 lbs. of coal generated a pressure of 98 lbs., while the one using oil and the same quantity of coal generated a pressure of 123 lbs. Crude oil was used and Illinois coal. The fires were allowed to burn out. Then follows a number of tests in detail, from which we find that the cost of kindling the fire with oil ranged from .75 to 5.40 cents each ; for wood it ranged from 19.25 to 56.25 cents each, and for waste from 11.8 to 17.6 each. As these are all special tests, they may be looked upon with suspicion, in that the difference is so great in favor of the oil ; but in order to set aside any such thoughts and to show that it is really due to the merits of the oil method, the record of the Chicago, Rock Island & Pacific Railway for a year is particularly interesting and valuable. This report shows that during the twelve months ending June 1, 54,094 fires were kindled at an average expense of 1.77 cents each, and a similar report from the Burlington, Cedar Rapids & Northern Railway shows that 7,674 fires were kindled at an expense of 1.97 cents each. Such a report as this should certainly go far toward convincing locomotive superintendents that oil is what they should and must use.

In the discussion following it, Mr. Atkinson said : "I have had some experience with the Le Bel kindler and made several tests. I have also made tests with oily waste and succeeded with the blower in getting up steam, about 70 lbs. in about one hour and a quarter. So far as I have tried the Le Bel kindler it has worked well. It did not work well at first, but we did not know how to use it. We put the kindler below the coal ; we afterward found it was better to make a mound of the coal and put the kindler on top ; and being of a resinous nature, when lighted it spreads down through the coal. I made a test between two engines, one with the Le Bel and one with wood, cold water in each case, and engines in same condition as far as we could get them ; it was considered that we should debit the Le Bel kindler with the cost of some coal. I found in the course of the experiment that we had to put the same amount of coal in in each case. It was not a question of raising steam ; it was one of getting the body of fire ready to go in service. I put 600 lbs. of coal with five sticks of the Le Bel kindler in the fire-box of an eight-wheel engine, 300 lbs. of coal at the beginning, and balance afterward. By the use of the blower, 70 lbs. pressure, we got first steam in 53 minutes ; 70 lbs. of steam in 78 minutes ; 120 lbs. of steam in 87 minutes. At that time the 600 lbs. of coal formed a body of fire about 4 in. thick on the grate, and the engine immediately proceeded to a train. In the other case, the lighting with wood, we used 95 lbs. of the best dry pine, scantlings and edgings, without sap, wood or bark. We put 300 lbs. of coal on to commence with, and afterward 200 lbs., making a total of 500 lbs. We got first steam in 37 minutes from time of lighting, 70 lbs. of steam in 57 minutes, and 120 lbs. of steam in 69 minutes. The coal fire was then very thin, and it was found necessary to add another 100 lbs. of coal, and wait until it ignited, before the engine was fit to move out and take a train."

Mr. Brown: We take it for granted that the roads using kindlers are using soft coal ; it ignites pretty freely. We are using hard coal, and I do not think we could obtain very great benefits from such a little flame in the first place. Our experience during the past 28 years has been lighting with wood in the usual way, and covering it slightly with coal, and allowing it to ignite as easily as possible, so as not to increase the heat on the plates too suddenly. Previously live coals were used for starting the furnaces. We had a furnace, in which we burned coke, and when we wanted to start a fire in the engine, we would run in a couple of shovelfuls in the centre of the fire-box and cover it with coal. It is an easy matter to ignite soft coal.

The noon hour of the first day's session was occupied in the discussion of the topical question : Which is safer construction for a ten-wheel engine, swinging centre trucks and flanged forward drivers or rigid trucks and blind forward drivers ? It appeared, from what was said, that a blind forward driver would be a dangerous thing ; but it would be difficult to tell whether a flange on the main driver is an advantage or not. The preponderance of opinion probably inclined toward the use of the flange, but excellent and satisfactory results are obtained without it, and there were no cases of derailment resulting therefrom reported.

There was a long report and a lively discussion on the subject of the bulging of fire-box sheets. In the report the committee gave the results of their investigations, and gave as an opinion that the bulging was usually caused by an accumulation of mud or scale, causing an overheating of the plates, the same effect being produced in some cases by contracted water spaces. Mr. Soule summed up the report and discussion by saying that he "gathered from the discussion and report that there are four principal causes which result in bulging fire-boxes—concentrated action of the fire, insufficient width of the water space, formation of scale on the sheets, accumulation of mud in the leg. I do not think we can improve the handling of our fires. Mr. Vauclain has thrown out the hint that the best escape from that trouble would be in the direction of enlarging our fire-boxes. As regards the width of the water leg, we are tied up there ; we are in between the wheels in nine out of ten engines, and cannot widen that space without reducing our grate area, which would be an evil in the other direction. As regards the formation of scale on the inside of the sheets, it makes me tired to think of the experience we have been through in that matter, and all the experiments that have been made

with different boiler compounds. That brings us down to the matter of mud, and to my mind our best chance for escape from these troubles lies right there. What we need is to have in every round-house where engines are handled in considerable numbers powerful pumps, with a plentiful supply of steam, so that we can go at the business in a sensible way, washing them thoroughly and frequently, throwing into them a large volume of water at high pressure."

In the report and discussion on the Best Material for Boiler Tubes, there was a unanimous sentiment in favor of charcoal iron, the following being a brief abstract of the report.

Circular letters were issued to members of the Association, asking for information, based on experience, in the use of boiler tubes made of different materials now in use, with a view of embodying in this report the views of those most interested. From replies received we find that all prefer iron and recommend it as the best material for locomotive tubes. The objections offered to the use of steel tubes are that they are more liable to "pit" and become eaten out sooner than iron, and in localities where water is bad there is greater difficulty in keeping them tight. The ends soon become hardened from frequent rolling and calking, which makes them so brittle that they break off at the fire-box end.

Some master mechanics report trouble from imperfect welds in the use of steel safe-ends with tubes, and *vice versa*. This arises from the fact that the melting point of steel is materially lower than that of iron, so that when iron is brought to the welding heat, steel is burned. Steel safe-ends may be perfectly welded to steel tubes, and iron ends to iron tubes; but when tubes and ends of different materials are joined, imperfect welds will result. It is, therefore, very important that tubes and safe ends be of the same composition. In recent years it appears that manufacturers have attempted to make a specialty of steel tubes, and the market is supplied with steel tubes, tubes with part steel at centre of the section, tubes with one side of steel, and tubes are offered, made by various processes, of both iron and steel.

The committee also recommended a set of standard specifications which are practically the same as those used on the Louisville & Nashville and the Chicago, Milwaukee & St. Paul railroads, the use of the etching test being especially recommended for determining the quality of the metal. In a topical discussion at the noon hour of Tuesday it was gathered as a consensus of opinion that the adjustable driving-box wedge is not a necessity, and that results that are perfectly satisfactory have been obtained with fixed wedges.

The report on Gauges for Sheet Metal was read and received without comment.

GAUGES FOR SHEET METAL TUBES AND WIRE.

If the recommendations made by this Committee produce the results that is hoped for their labor will not have been in vain. Their purpose has been to establish a gauge for thin metals that will take the place of the numerous gauges that are now in use, and whose numbers are not only confusing to the uninitiated, but puzzling even to those who make frequent use of them on account of the entire lack of association between the numbers and the actual sizes that they represent.

To this end your Committee opened communication with a similar committee of the American Society of Mechanical Engineers, and after much correspondence a joint meeting of the two committees was held at Hotel Lafayette, in Philadelphia, on November 7, 1894, when the following resolution was passed:

"*Resolved*, That we, the members of the Joint Committee of the American Society of Mechanical Engineers and the American Railway Master Mechanics' Association, earnestly deprecate the use of any of the numerous wire and sheet metal, or other gauges.

"In practice we recommend the use of micrometre calipers or notched gauges, the latter with notches of dimensions suited to the convenience of the different industries, and, where necessary, different selections of sizes in thousandths of an inch, suited to each trade, being incorporated in their working gauges; provided, however, that these are always dimensioned in thousandths of an inch, and marked in terms thereof, the number of thousandths being marked opposite each gauge notch, thus, .001".

"We further recommend that the members of the various engineering societies assist the introduction and general adoption of this system by using it in their own work."

(The American Society of Mechanical Engineers' Committee reported this resolution to their Society at the December meeting in New York, and also stated that the movement was gaining ground in Europe and Canada, the French Government having already abolished the arbitrary gauge, making a decimal metric system the legal measurement.)

Immediately after this joint meeting, your Committee sent out circulars of inquiry to members of the Association and manufacturers, asking for their views relative to establishing the decimal system, and submitting a list of sizes which it was proposed to include in the solid notched gauge, and giving for convenience the nearest equivalent in the Birmingham gauge.

In order to show the confusion that really exists they give a scheduled list of 25 gauges in tabular form for the purpose of comparison, and a formidable array it does make. They have, however, received a great deal of encouragement from those who have taken the trouble to reply to their circular of inquiry, as these answers were almost unanimously in favor of the adoption of the decimal gauge. After receiving these replies another joint meeting of the two committees was held, when the following resolution was unanimously agreed to:

"*Resolved*, That while the micrometre gauge should be used for test purposes in the laboratory, yet for general shop use a solid notched gauge is desirable. The form of this gauge should be an ellipse whose major axis is 4 in., the minor axis 2.5 in., and the thickness .10 in. There should either be one hole .75 in. diameter in the centre, or one at each of the foci for lightening and convenience. This gauge must be plainly stamped with the words "Decimal Gauge" in letters .200 in. high, and below this the name of the trade which the group of notches is to cover; these groups to be selected with reference to the needs of the several trades.

"All sizes of notches to be marked in thousandths of an inch without a zero prefixing the decimal point, but with inch-marks after the figures, thus, .002".

"It is also the intention of this Committee that in ordering material, the term "gauge" shall not be used, but merely the thickness in thousandths of an inch."

The object of the elliptical form is to permit a ready distinction from the old-style circular or rectangular gauges now existing, and also to make it more convenient for the vest pocket.

As explained in the resolution of November 7, 1894, various trades may have different groups of notches to suit the necessities of each, but as all notches will have the dimensions given in thousandths of an inch, there can arise no ambiguities, as similar notches will have the same designation on any one of the gauges; thus .085" would mean the same whether on the master mechanics', tinners' or glass manufacturers' gauge.

We now have to recommend to this Association for its adoption as standard:

1. The micrometre caliper should be used for laboratory and tool-room work, and in the shop when specially desired.

2. The solid notched gauge should be used for general shop purposes.

3. The form of this gauge shall be an ellipse whose major axis is 4 in., the minor axis 2.5 in., and the thickness .1 in., with a central hole .75 in. in diameter.

4. The notches in this gauge shall be as follows:

.002"	.004"	006"	.008"	.010"	.012"	.014"	.016"	.018"
.020"	.022"	.025"	.028"	.032"	.036"	.040"	.045"	.050"
.055"	.060"	.065"	.070"	.075"	.080"	.085"	.090"	.095"
.100"	.110"	.125"	.135"	.150"	.165"	.180"	.200"	.220"
.240"	.250".							

5. All notches to be marked as in the above list.

6. The gauge must be plainly stamped with the words "Decimal Gauge" in capital letters .2 in. high, and below this the words "Master Mechanic."

7. In ordering material, the term gauge shall *not* be used, but the thickness ordered by writing the decimal as in above list. (For sizes over ¼ in., the ordinary common fractions may be used.)

We appreciate the fact that the standards are practically worthless unless the members put them into everyday use, and we heartily urge them, not only to indorse these recommendations, but to use them.

The Pratt & Whitney Company, of Hartford, Conn., offer to furnish the Solid Elliptical Gauges, notched as shown in the cut, for $5 each, if the use of the gauge warrants their making the necessary tools for their production.

UTILIZATION OF RAILROAD SCRAP MATERIAL.

Your Committee upon the subject of the "Utilization of Railroad Scrap Material, and the Best Method of Handling the Same," begs leave to submit its report as follows:

It is proper to state at the outset that some little difficulty has been experienced in attempting to gain a full expression of facts and opinions from members, owing to the fact that some members consider it unnecessary, if not improper, for a railroad to have any scrap pile at all. This is, of course, based upon the use of the word "scrap" as synonymous with "junk." It has seemed to your Committee that this was not

the meaning intended to be conveyed by the wording of the subject, else there would be no question of the utilization of scrap on the part of the railroads. "Scrap" has therefore been treated as occupying an intermediate position between second-hand material and junk. It may be one or the other. It is more commonly both.

The subject naturally divides itself into the two heads suggested in the title—Handling and Utilization.

The first will include gathering, sorting, and arranging, with reference to possible future use or for sale.

The second—and in treating this branch of the subject it has seemed desirable to depart from the common practice of tabulating replies, for reasons that will be stated later on—will include the results of the experience of members in working over second-hand material.

HANDLING SCRAP.

Your Committee has found it impossible to formulate any rule for the handling of scrap which shall be capable of general application, owing to the varying conditions prevailing upon different roads. For instance, many railroads have shops of all kinds located at a single point.

Others have shops at several widely separated points, and in many instances the shops relating to the locomotive department are entirely separated from those of the car department.

The distance of any of these shops from each other, or from the scrap market, taking into consideration the cost of transportation, also has an influence. It is believed, however, that the suggestions which are applicable in the case of a single central plant may have a partial bearing upon the several smaller shops of a system.

In the case of a single plant, the collection will consist only in bringing to this central point all the various articles of scrap materials accumulating upon the various divisions, and such as are picked up along the right of way. With several smaller shops, it would seem best that each should be treated in the light of a central point. By this it is meant that the scrap naturally belonging to it or accumulating in its vicinity should be sorted with reference to two general classes—viz., that which is of probable future use at that point, and that which cannot be utilized at that point. The latter should be shipped to the principal shops for sale or for utilization there.

It is suggested by one member that such scrap as is obviously of no use, except for sale, may be kept on hand until there is such an accumulation as to enable handling in carload lots. With this exception it would seem that the treatment to be followed in both cases should be substantially similar.

As the material is unloaded from the car it may conveniently be handled under two classifications—as to material, and as to future disposition. This should be done under competent supervision. The first classification may be as finely subdivided as the circumstances in each particular case seem to indicate, but should at least cover the several metals found.

The second classification may cover, first, material that can be used again, and is therefore plainly second-hand material only; second, material that can be used again, but which requires additional work or preparation before using; and, third, material that can only be sold as scrap. The conditions in each case will govern the amount and kinds of material that will be retained or sold, whether it be all or none.

It will be noted that the plan suggested, and which is made up from items of the practice of several members, provides for a double inspection of the scrap material, and for the turning into stock of material that may be used again without preparation.

This naturally implies a separation of the material at the main scrap pile into other classes, according as the parts belong to cars, locomotives, or the roadway, from which the proper credits may be determined for the several departments.

Only one of the members has suggested the arrangement of bins. This is that they may be placed upon a long platform upon a level with the car floor, and about 6 or 8 ft. from the edge of the platform. The man in charge instructs the laborers in which bin to deposit the various classes of material.

As previously mentioned, and as stated in one of the replies to your Committee's circular, "circumstances and conditions with the different railways are so diverse that each one separately must be governed by the economic features presented in its location, considering carefully prices of new material, scrap values, transportation, and handling."

Your Committee is, however, of the opinion that if a road is in position so that it seems desirable to handle scrap material to any extent, a careful supervision by one capable of exercising sound judgment will be found to be an economic measure. The general principles which may well govern the management of the whole subject have been laid down in a paper read during the past year before one of the railroad clubs. They are as follows:

First. The scrap pile should be in charge of persons of as much intelligence as is required for any position on the railroad.

Second. The method of handling the scrap material which is to be put to further use should be as systematic and carefully elaborated as that of handling new material.

UTILIZATION OF SCRAP.

In the matter of the utilization of scrap material, after it has been sorted and so arranged that systematic use is possible, it has seemed best to your Committee, in view of the variety of uses to which various parts of cars and locomotives may be put, to present, in a condensed form, the experience of the members who have reported. It is somewhat disappointing that, with the exception of one or two instances, there are no figures upon which to base a report as to the difference between the cost of working over old material and the price of the new. This is partially accounted for by the fact that most mechanics would use new material in preference to working over old, were it not that the latter course is, in a measure, unavoidable.

It appears to be a fact, also, that there are few instances in which scrap and scrap accounts are kept so systematically that figures even approximating accuracy are possible. For the benefit of such as prefer or are obliged to devise methods of utilization of such material as is at hand, the various suggestions given may prove of some value.

Many classes of scrap may be conveniently used without passing through the foundry or the rolling mill. Bolts may be cut off, straightened, and recut. As the bodies of bolts are seldom injured beyond bending—if broken, the breakage is their condemnation—this practice may be continued indefinitely, or until the length is so reduced that they will answer only for track bolts.

One member carries the process still further, and when the bolts are too short for use as bolts, they are used as rivets. A method of treatment of old bolts is suggested, to place them over night in a heating furnace, which serves the purpose of annealing and causes the hard scales to drop off when they are straightened under the hammer. It also softens the metal and saves wear upon the bolt-cutting dies. A saving of about $1\frac{1}{4}$ cents per pound is claimed for this course of treatment compared with the cost of new bolts. Small bolts are cut down and made into lag screws at a saving of about 2 cents per pound. One member reports 40 per cent. of all bolts as made from old material.

Nuts may be closed up and recut. It has been suggested that they should be pickled in a weak solution of hydrochloric acid, to remove rust and prevent undue wear of taps.

A large proportion of the wrought iron which finds its way to the scrap pile can be utilized, provided it has been so sorted that suitable pieces for any special purpose can be found without the expenditure of so much time as to neutralize the apparent economy.

Arch bars, brake connections, brake staffs, bottom straps, drop-door hinges, door slides, etc., are of such section as to be capable of use as carry irons, truck hangers, brake-jaws, brake forks, straps for coal cars, etc.

Bridge iron and old iron turn-tables furnish material for repairs to locomotives and tenders. Turn-table plates serve for cross bracing for tender frames, and the channel iron of old bridges will make tank frames and bolsters.

Truss-rods may be used by welding on new ends, or, when past this point, may be cut up for various purposes, as bolts or brake connections.

Tank and boiler-sheet scrap may be used for ash-pan sides and ends, bumper beam plates, wheel covers, large sizes of washers, shoveling sheets on tank floors, floor sheathing under forges, bridges for freight-house platforms, shims, liners, slides, etc.

Links and pins, if not too badly bent or worn, may be straightened and returned to stock. The consensus of opinion is to the effect that welding of such parts is not in the line of economy, though in many instances broken links are welded, and, if circumstances require, standard gauge links may be readily converted into links for narrow gauge. Old links and pins are made up into hammered iron for side and main rods, engine links, etc.

Coil springs may be utilized by mating an unbroken inner coil with an unbroken outer part. The life, however, will be short, as the elasticity has probably been impaired. Pieces of broken coil springs of large size may be used for pinch bars, jack-levers, and buggy bars for engines.

Flat or semi-elliptic spring leaves may be used for repairs

to other springs, rod liners, equalizer rigging, keys, plates, and spring clips, small wrenches, brake-beam guide springs for passenger-car trucks, drawhead keys, side plates for split switches, etc.

Old flues are sometimes used to advantage in making drain gratings under water tanks, for cattle guards, over cinder pits, etc., and for ash-pan and other split keys. In this case they are flattened and punched to the required shape under the steam hammer. One member calculates a saving of 50 per cent. in using flues for cinder-pit gratings. Flues also make excellent material in the manufacture of whistling and crossing signs, and for fences about depots and grounds.

Scrap axles are used for a variety of forgings, such as equalizers, pedestal and frame braces, brackets, mud-rings, smoke-box rings, equalizer fulcrums, arch bars, drawbars for engines—both front and back, swing-beam hangers, Miller hooks, truck frames, engine and tender chafing plates, wrenches, piston-rods, crank and rod-pins, main and connecting rods, rod-straps, etc.

One of the members of your Committee utilizes narrow-gauge axles, which are straight in the centre, by cutting off the journal ends and cutting the middle part in two pieces. By welding three such pieces together, making two new out of three scrap axles, a considerable economy has been developed.

Old axles may frequently be worked into virtually new axles, which come up to the original standard in strength and elasticity. A good method, where there are suitable facilities, appears to be to roll the old axles into bars $3 \times \frac{3}{4}$ in. and cut into 3 ft. 6 in. lengths. These plates are placed together in sufficient numbers to make the axles required. By this method the particles seem to become elongated and produce fibrous metal capable of enduring ordinary tests and service.

Old hand-car axles are used to make crank axles on new hand-cars, at a saving of $1.25 on each axle. Surplus stock of this class is made up into fence-posts along the right of way.

Piston-rods, hand-car axles, small car axles and main rods can often be conveniently used for the motion work of the locomotives, being case-hardened after finishing.

Upon one road old steel driving-axles are used over again at a reduced size, being annealed by wood fire during the several stages. For instance, an 8-in. axle is reduced to serve at $7\frac{1}{2}$ in., then at 7 in., and finally at $6\frac{1}{2}$ in., that being the smallest size used. From this stage it is made into crank-pins, and from that to blacksmiths' tools. Old steel tender-axles are used awhile as engine-truck axles, and finally end in the same manner. Guide yokes are sometimes made from iron axles.

Old tires are in some instances converted into rod straps for engines, filling pieces for frog points, and blacksmiths' tools. Your Committee have no figures upon the economy of working up old tires, with the exception of the experience of one member who found that the cost of some hand-hammers made of old Krupp tire was $8.98 per dozen, as against $4.50 per dozen for new hammers. He discontinued the operation.

However, at the same shop, coal hammers, lining-bars, claw-bars, and some classes of wrenches have been made at a profit from the same material.

Fish-plates are successfully converted into rail braces at a cost of a cent apiece.

Worn-out steel rail is converted into brake-beams by working out the head of the rail to the same thickness as the web, leaving the base in its original shape. This is then sheared to the proper shape, making a good beam out of worthless material at a cost of about 40 cents for labor.

There is such a variety of uses to which a large part of the scrap pile may be put, that it seems unnecessary for your Committee to enumerate more. It is understood, however, that the handling of scrap must be carefully regulated, or the apparent economy will be entirely lost in the increased time expended in looking for a suitable piece for any special purpose. It is also to be understood that such parts as are capable of being worked up for any well-defined purpose should be so treated at the earliest opportunity, and the completed article turned into stock in the same manner as is new material.

In the matter of some classes of material it is easy to throw away time and money in trying to save it, but a discriminating man can usually save his salary several times over in the work of scrutinizing what comes to him as scrap, and taking measures to save the good material and get rid of the bad as quickly as possible.

There was a long discussion on the report concerning piston heads, each member evidently having had his own trials and tribulations with broken rods. The Laird cross-head was especially condemned; and it was the universal opinion that the shoulder at the cross-head end should be dispensed with and that a great deal of the difficulty arose from the high speeds at which the reciprocating parts are run.

PISTONS, PISTON-RODS, AND FASTENINGS.

The Committee having this subject in charge made a long report that consisted for the most part of descriptions of the three types of pistons that are now used on American locomotives, winding up this portion with a list of weights of pistons of various sizes that are used. In regard to piston-rods, the inquiries of the Committee have led them to the conclusion that the taper fit for both ends of the piston-rod is well supported by successful practice, and may be considered as the standard arrangement. There are a considerable number of details which, however, may seriously affect the results in service. "It seems to be pretty well proven that a square shoulder between the taper fit and the cylindrical portion of the piston-rod (at either end) is a bad arrangement, as it localizes all bending strains at such a shoulder and invites fracture at that point. This is getting to be pretty generally recognized, and is overcome in either of several ways; the first and most obvious way being to introduce a large fillet in place of the square shoulder; the next step being to introduce a blunt taper in place of the square shoulder; the next step being to carry the original taper out beyond the piston or cross-head fit and until it merges into the cylindrical surface of the piston-rod itself. Still another recourse is now being availed of to a considerable extent, and consists of reducing the section of the piston-rod for a short distance outside of the cross-head fit (this is never done at the piston fit), which arrangement still further tends to relieve the cross-head fit itself from bending strains (and consequent tendency to get loose), and localizes those bending strains in a reduced cylindrical section, which is well adapted to receive and absorb them. This practice has been more extensively followed on the Michigan Central Railroad than anywhere else, and is said to have resulted in an almost complete freedom from broken piston-rods. The same idea carried to a further extreme is to reduce the entire length of the piston-rod between the piston fit and the cross-head fit to a diameter less than that of the large end of the taper fits themselves, but this entails the necessity of using a split stuffing-box, which by many is considered to be very objectionable.

"The usual and preferred method of fastening the piston-rod into the piston is by a nut. Experience has shown that it is important that this nut should be sufficiently thick to prevent any possibility of its threads being battered by the blows on the piston, which action would, of course, result in the nut becoming loose and the fit between the piston and piston-rod becoming impaired. A few roads use a brass nut in this place, claiming that a forged iron or steel nut gives trouble from rusting, and in some instances has to be split before it can be taken off. A very few roads dispense with the nut entirely; the end of the taper fit of the piston-rod being riveted over into a countersunk recess in the faces of the piston itself. It is usual to take the further precaution in such instances of inserting a key through the hub of the piston and taper fit of the piston-rod."

In handling the packing-rings the Committee give a list of the various widths of packing rings that are in use on a number of roads, and it is interesting to note the wide variation in the dimensions of rings that are to do the same work. In one instance they are 1 in. wide in a 16-in. piston, and in another only $\frac{1}{2}$ in. wide on one 19-in. in diameter. The probability is that those master mechanics who are using wide rings have not noted the gradual reduction in the width that has been going on for some time, and still use the old sizes without having given the matter much thought. It is evident, however, from indicator cards that there is no more perceptible leakage past a $\frac{1}{2}$-in. ring than there is past one of double its dimensions.

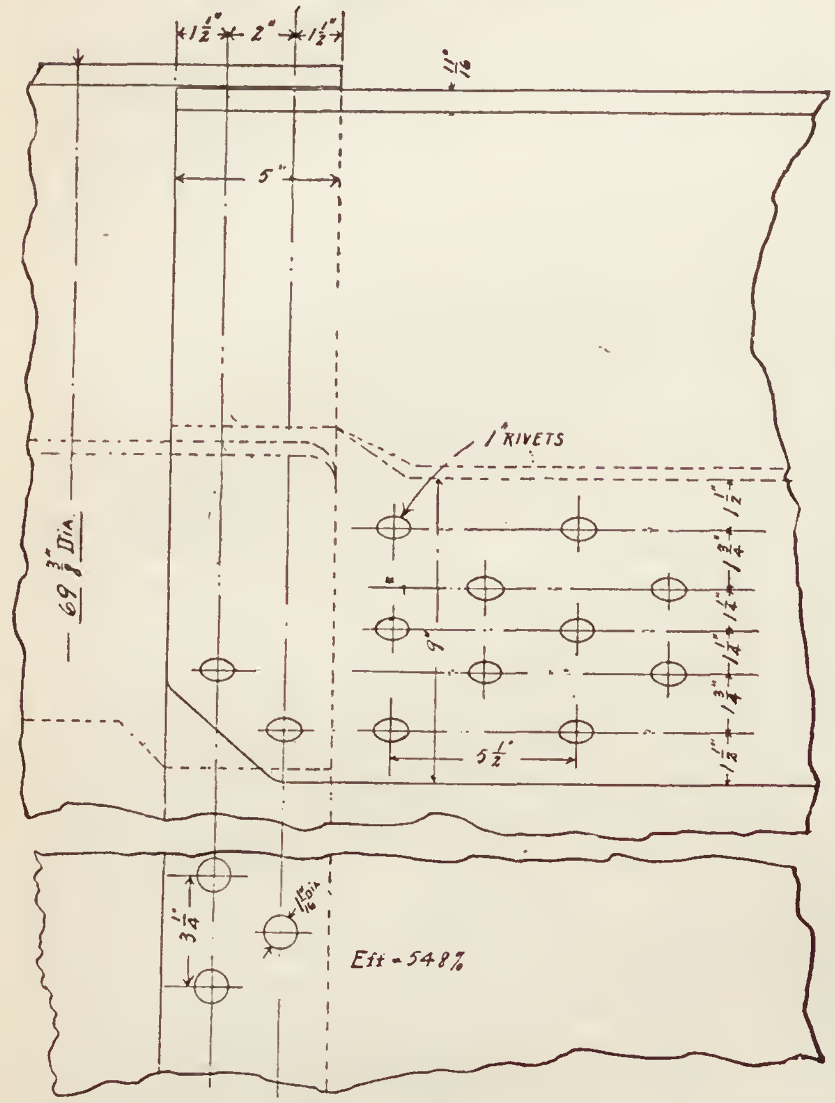
The conclusions drawn by the Committee in closing its report are as follows:

"That for pistons of moderate diameter and for use in slow-speed engines, there is an open choice between the bull-ring form and box form, while for pistons of any diameter, if for high-speed engines, the single-plate type presents the important advantages of lightness combined with strength. In piston-rod fastenings the taper fit with nut at the piston end and key at the cross-head end seems to be the arrangement which is justified by the best practice. The tapers which are in current use vary between the extremes of $\frac{5}{8}$ in. in diameter in 12-in. length to $1\frac{1}{2}$ in. in diameter to 12-in. length, while a fair mean representing average practice may be considered to be 1 in. in diameter in 12-in. length."

RIVETED JOINTS.

The estimate of the value put upon this report will depend upon the attitude that is assumed toward it by the reader or

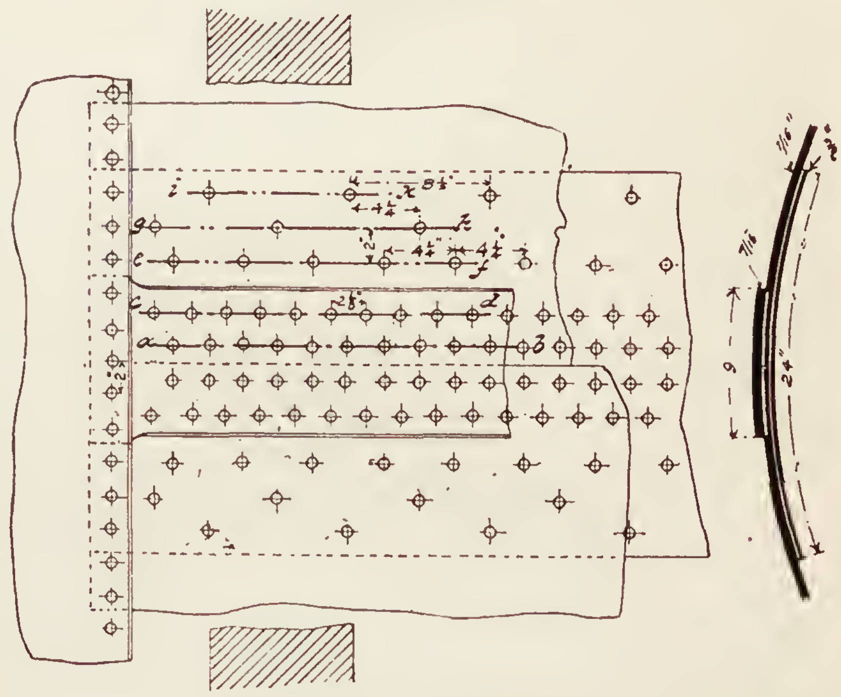
Brooks Loco. Works.
Quintuple riveted lap joint.



Sketch No 9

listener. If the former takes it up in the spirit of the student that is searching for information, he will probably find therein that when the subject is thrown open for discussion he has but a vague idea of what has been said, since the training of this average listener does not include a course in the mental solution of problems in higher mathematics. While the report is a valuable compilation for the student, it should be read in abstract from which all of the mathematics have been abstracted.

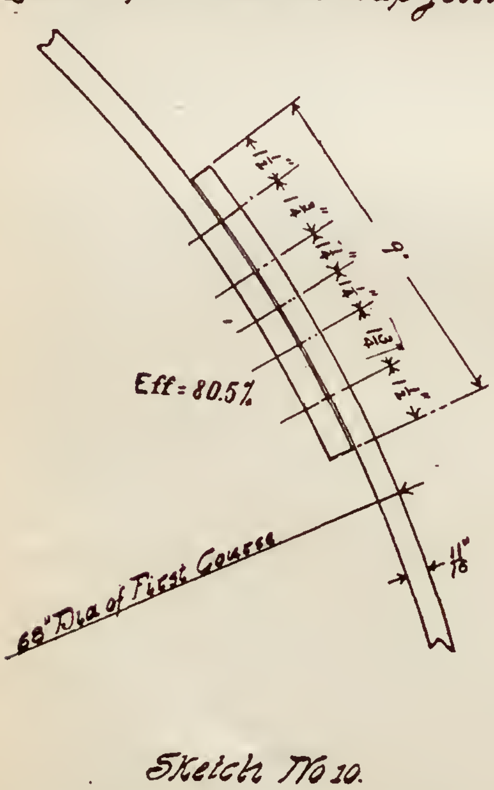
Sketch No 26



All rivets ⅞", spaced 2⅜ apart centre to centre in longitudinal seams - in cross seams 2" nearly

The report starts out with the assertion that the Committee "decided to make this report elementary," and then proceeded to define the various terms of boiler nomenclature. All sorts of joints were defined, a name was given to every conceivable strain to which a rivet or a joint or a plate can be subjected, and this done, as a sort of preliminary canter, the symbols are lined up and started over the course. In the early portion of the report there is no evidence of any original work on the part of the Committee, other than the gathering in of the results of the investigations of Unwin, Reuleaux, and Haswell. This to be sure is well done, and deserves the appreciation and thanks of the student.

Brooks Loco. Works.
Quintuple riveted lap joint.



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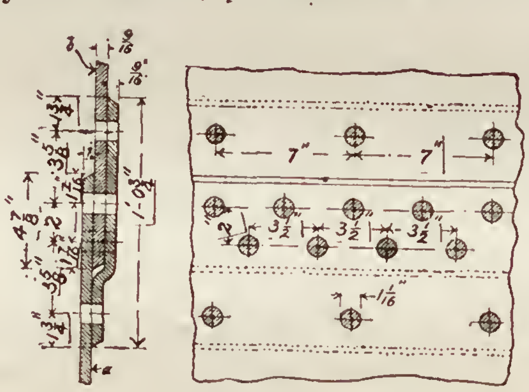
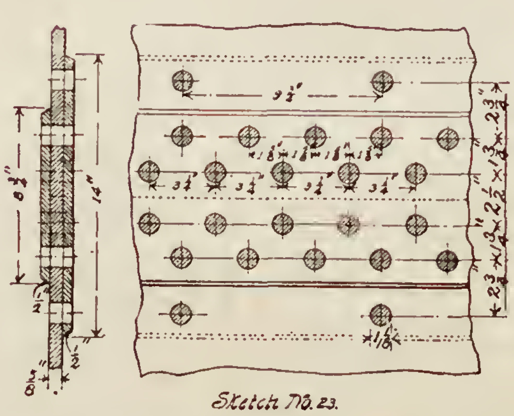
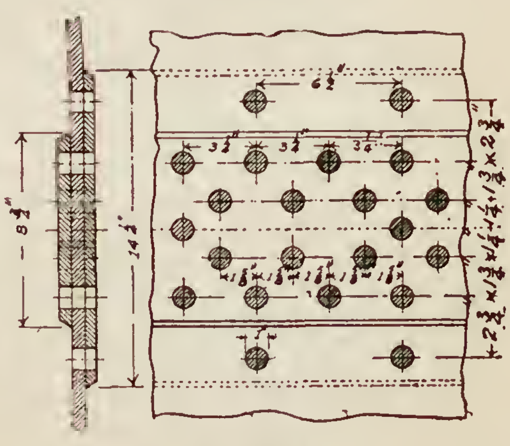


Sketch No. 21

Sketch No 22



Sketch No. 23.



Sketch No 24.

a compilation of the best researches on the subject, and will be content; but if the report is thrust upon him as a listener, he will probably become quickly confused in the rapidly succeeding series of mathematical formulæ, and find that the limit of his intellectual elasticity has been so far exceeded

Occasionally there is an oasis in the shape of an empirical assertion where the non-mathematical listener can rest for a moment, until he follows the caravan to the next green spot. The first appears in the form of a rule for ascertaining the force required to break through the margin of a riveted joint,

which, being interpreted, may be made to read, "take the continued product of four times the tensile strength of the plate per square inch, the thickness of the plate in inches, and the square of the margin in inches and divide the result by three times the diameter of the rivet in inches, and the information sought is your own."

Again: "For shells $\frac{5}{8}$ in. thick or over, the thickness of the tube-sheets should be $\frac{1}{2}$ or $\frac{9}{16}$ in. For shells less than $\frac{5}{8}$ in. thick, it is good practice to make the tube-sheet $\frac{1}{8}$ in. thicker. The thickness of the outside door sheet should be the same as the thickness of the part of the shell of largest diameter.

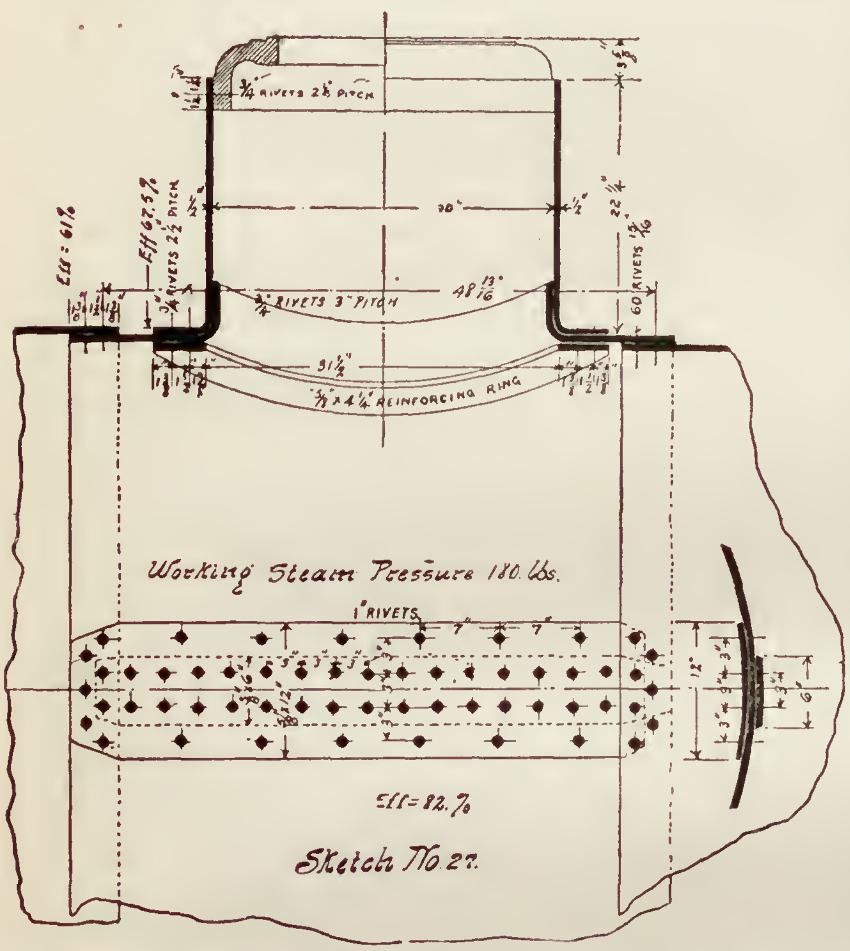
"The throat-sheet should be made $\frac{1}{8}$ in. thicker than the shell, to allow for the thinning produced by flanging.

"With shell plates $\frac{5}{8}$ in. and over, the throat-sheet may be made only $\frac{1}{16}$ in. thicker than the shell-sheet, and in some cases has been made no thicker than the shell-sheet.

"The fire-box throat-sheet, if separate from the back flue-sheet, should be of the same thickness as the fire-box side-sheets.

"If but one welt is used with a butt joint, the welt should be from $\frac{1}{16}$ to $\frac{1}{8}$ in. thicker than the main plates. A welt used with the lap-joint should be as thick as the main plate. Welts used with a butt joint (on which two welts are used) may have any thickness between five-eighths of and the full thickness of the main plates. The thicker the welt the more permanent the calking.

"The rivet holes should not be over one-sixteenth larger in



diameter than the normal diameter of the rivets, and the calculations of the strength of the rivet should be based on its driven diameter, which is the diameter of the hole."

In discussing the matter of materials, the report says:

"It has now become the universal practice to construct locomotive boilers of steel. As this Association has proposed, and adopted a standard specification for boiler and fire-box steel plate, in which the minimum limit of tensile strength is 55,000 lbs. per square inch, we shall base our calculations upon this figure.

"All of the railroads that have replied to the questions of our circular of inquiry report that they use iron rivets, and the contract locomotive works which have replied recommend iron rivets and use them in boiler construction, unless steel rivets are specified. The only objection which your Committee has to the use of steel rivets is that there is danger of overheating them in the hands of the rivet boys usually employed for this work, in which case their strength is materially diminished. It may be said further that it is usually not difficult to obtain sufficient shearing strength with iron rivets in a well-designed joint.

"From the United States Government tests of riveted joints, made on the Emery testing machine at the arsenal at Watertown, Mass., we find that 38,000 lbs. per square inch is a fair average value for the shearing strength of rivet iron in riveted joints. In the tests of riveted joints made for the Pennsylvania Railroad at the Watertown arsenal in April, 1886, and March, 1887, the rivet iron showed an average shearing strength of about 43,000 lbs. per square inch in the joints that failed by shearing. Of course, if a particular kind of rivet iron is used the shearing strength of which is known to be greater or less than 38,000 lbs. per square inch, the actual shearing strength of the iron should be used in proportioning the joints in which that kind of iron is to be used for rivets, and if steel rivets are to be used, a shearing strength of about 50,000 lbs. per square inch may be allowed.

"Moreover, the method by which the rivet holes are made in the boiler plate also affects the tenacity of the net section of the metal. If the holes are drilled, or punched $\frac{1}{8}$ in. smaller than the finished size and reamed, or punched to size and the plates are annealed thereafter, the net section of the plate shows increased tenacity, the proportion of increase depending on the thickness and hardness of the plate and the pitch of the rivet holes. If, however, the plates are punched to size and the plates are not annealed after punching, there may be excessive tenacity, or there may be a deficiency of tenacity in the net section of the plate. Punching alters the structure of the metal immediately surrounding the hole, and makes the net section of plate non-homogeneous. This weakens the net section of plate, and the weakening thus produced may more than neutralize the excess in tenacity produced by the grooved specimen action.

"Your Committee recommends either that punched holes shall be reamed or that the plates containing them shall be annealed after punching. If this becomes the practice, there will always be excessive tenacity in the net section of plate. The amount of the excess cannot be determined without recourse to experiment, and in deducing the dimensions of the joints which we recommend to you, we have not allowed anything for this increase in strength.

"Moreover, it is our opinion that such excess should not be counted upon unless it is shown to exist, and its magnitude is determined by experiments upon joints which are *identical in every respect* with those for which allowance is to be made.

"There is also a certain amount of friction between the adjacent plates in a riveted joint, caused by the longitudinal stress in the rivets, which stress is induced by the method of driving the rivets and by the contraction of the rivets by cooling. While the friction between the plates is capable of resisting or neutralizing some of the tension which the joint bears, it is the opinion of your Committee that it should not be considered as an aid to the strength of the joint. Concerning this, Professor Unwin says: 'English engineers entirely neglect the friction in estimating the strength of the joint, the reasons assigned being that the amount of tension in the rivet is not ascertainable, and that vibrations and other causes tending to slightly elongate the rivet may, in course of time, destroy it altogether.'

"When rivets are driven in punched holes we consider it good practice to have the smaller diameter of the holes come together, because the rivet fills the hole more completely than it would if the holes came together in any other way, and the upsetting of the rivet tends to draw the plates together.

"Thoughtful consideration will show that with a given thickness of plate a decrease in the diameter of the rivet requires a decrease in the pitch, if the joint is to be kept as efficient as possible, and a decrease in the diameter of the rivet permits a decrease in the width of the margin—in fact, it may *require* a decrease in the width of the margin to make it possible to calk the joint permanently.

"Now, in fire-boxes a large margin is apt to become burned; therefore, in order to keep the margin and the overlap small, it will be necessary to adopt small rivets and a pitch much smaller than the greatest pitch which can be used and still have a tight joint with plate of the thickness used.

"If a joint is made between plates of different thicknesses, the dimensions of the joint and its efficiency should be calculated for the thinner plate."

The last 24 pages of the report are devoted to a mathematical analysis of the strength of various types of riveted joints. The method pursued is to take a joint of given dimensions and ascertain the percentage of strength that it bears to the full plate, and then so modify those dimensions that a higher percentage will be obtained. As the first example, where two $\frac{9}{16}$ in. plates are brought together with a lap-joint, with a single row of $1\frac{1}{16}$ in. rivets spaced $2\frac{5}{8}$ in. from centre to centre, it is found that the least resistance is that opposed to shearing, but that this is only 41.4 per cent. of the strength of the full plate. But "if the size of the rivet remain unchanged, the efficiency can be increased by making the pitch smaller, and when the resistance to tearing along the net section equals the resistance to shearing the greatest efficiency that can be obtained by changing the pitch has been reached."

This same method is carried through a large number of joints, the analysis naturally increasing in length and elaborateness with the increasing complexity in the design of the joint. Without following this work out in all of its details, we give the Committee's summary of the efficiency of a number of joints that are now in actual service, the engravings of which are here reproduced.

Sketch Number.	Efficiencies.
9 and 10	80.5 per cent.
21	77.7 "
22	86.6 "
23	77.3 "
24	84.6 "
26	90.4 "
27	82. "

In discussing the report on the Wear of Driving-wheel Tires, Mr. McConnell said:

"In order to determine what effect high speed, increased weight, and increased boiler pressure had on the wear of the tire, I have inspected some of our locomotives covering a period of 20 years. I started in with five 16-in. cylinder, 69-in. driving-wheel, carrying 140 lbs. pressure, time-card speed of 22 miles an hour. After they were worn out they were rebuilt with 17-in. cylinder, 150 lbs. of steam, and increased speed to 25 miles. We afterward built them 18-in. cylinder, 160 lbs. pressure and increased speed to 33 miles. We have some engines now with 180 lbs. of steam, time-card speed, 41 miles. The 16-in. cylinder, with 140 lbs. pressure had about 28,000 lbs. weight on the driving-wheel, and the average wear of the tire on this engine was 14,722 miles per $\frac{1}{16}$ in. of wear; with the engine rebuilt, steam pressure increased to 150 lbs., speed 25 miles, tire wear decreased to 11,092 miles per $\frac{1}{16}$; with the 18-in. cylinder, carrying about 73,000 lbs. weight on the driving-wheel, 160 lbs. of steam, 10,320 miles per $\frac{1}{16}$. These same engines, when we increased the speed to 33 miles, and 180 lbs. pressure, we got 3928 miles to $\frac{1}{16}$; with the engines on the fast mail, the time card speed 41 miles weighing 107,000 lbs., and 69,000 lbs. weight on the driving-wheel, 180 lbs. pressure, the average mileage was 6717 per $\frac{1}{16}$. That shows the effect of high speed, high steam pressure and increased weight on the driving-wheel. There was a variety of tires—Nashua, Union Steel, Midvale, Krupp, and others; the diameter of the driving-wheel was the same."

Before adjournment the annual election of officers was held, with the following result: President, R. C. Blackall; First Vice-President, R. H. Soule; Second Vice-President, Pulaski Leeds; Secretary, Angus Sinclair; Treasurer, O. Stewart.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.

SECOND SERIES.—CHEMICAL METHODS.

XVI.—METHOD OF TAKING COLD TEST AND CHILLING POINT OF OILS AND OTHER LIQUIDS.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(*Continued from page* 257.)

OPERATION.

For cold test, put about 1 oz. of the liquid to be tested into a common 4 oz. sample bottle, and place a short stout thermometer in it. Then place the bottle in a situation where the liquid will become frozen, using for this purpose a freezing mixture if necessary. When the liquid has become solid throughout, remove from the cold and allow the liquid to soften, thoroughly stirring and mixing it at the same time, by means of the thermometer, until the mass will run from one end of the bottle to the other. Now grasp the bottle by the neck, having in the same hand a little waste or a towel, which encloses the thermometer, withdraw the thermometer through the waste, to wipe it far enough to see the mercury, and read the temperature. The reading is the cold test of the liquid.

For chilling point, where it is desired to know whether the liquid remains clear at any given temperature. Use the same bottle, amount of liquid, and thermometer as for cold test. Expose the liquid to the given temperature, or a little below, stir it with the thermometer occasionally, until the temperature of the whole liquid becomes that desired, then allow to stand for the time specified, at the end of which observe whether the liquid remains transparent and free from flocks or scales of congealed constituents. If so, it stands test.

For chilling point, where it is desired to know at what temperature flocks or scales of congealed constituents or more or less opacity takes place. Use bottle, amount of liquid, and thermometer as before. Expose to a temperature 5° colder than that at which the liquid is perfectly clear and free from flocks or scales, and allow the temperature to fall to that of the source of cold, with constant watching and occasional stirring. Lower the source of cold 5° more and treat as before. Proceed in this way until opacity or flocks or scales begin to show. The reading of the thermometer when this is the case is the temperature sought.

APPARATUS AND REAGENTS.

The 4 oz. sample bottles are readily obtained in the market. The round form is preferable. They are about 1½ in. in diameter, and about 6½ in. long over all.

The thermometer best adapted to cold tests are chemical thermometers with graduation engraved on the glass tube and white enamel background behind the mercury column. Since they are used as a stirring rod during the operation, in a moderately viscous liquid, they should be made of strong tubing. Of course the graduation should embrace the range of the cold tests to be taken. Graduation finer than single degrees is not necessary. For taking chilling points special thermometers may be obtained in the market, which are so made that the mercury column, even at quite low temperatures, projects above the bottle, so as to be easier read. The same thermometers may of course be used in taking cold tests, provided they are strong enough and long enough.

Quite a number of methods have been proposed for obtaining the cold to be used in taking cold tests and chilling points. None, however, are apparently so simple, easily manipulated, and expeditious as freezing mixtures. Three cases are to be considered.

1. *For cold test.* If the cold test is above 35° F. use a mixture of snow or pounded ice and water in any suitable non-conducting vessel. Quite a good sized-vessel and a plentiful supply of snow or pounded ice works best. The bottle with oil and thermometer is plunged into the liquid and allowed to remain until the liquid is frozen solid. For cold tests from 35° F. down to zero, use a mixture of two parts by weight of snow or pounded ice and one part of common salt. The same remarks as above in regard to vessel, plentiful supply and manipulation apply. For cold test from zero F. to 30° below use a mixture of three parts by weight of crystallized calcium chloride and two parts of snow or very finely pounded ice. The crystallized calcium chloride, if obtained in the market, should be crushed in a mortar to pieces not larger than wheat kernels. For cold tests approaching the lower range of the above limit, the vessel should be non-conducting and should be cooled to 32° F. before putting in the calcium chloride and ice. The crystallized calcium chloride may be bought in the market, but the following method gives a very cheap and efficient article from materials always at hand in every good laboratory—viz.: Put about a pound of pulverized carbonate of lime—marble dust works best—into a casserole holding three pints or two quarts, and pour concentrated commercial hydrochloric acid on it, little at a time. A neutral solution of calcium chloride is formed very quickly, after each addition of acid, and in a short time the mass becomes wet enough to be stirred to facilitate the action. Proceed with the addition of the acid until nearly all the marble dust is dissolved, taking care to avoid an excess of acid. Pouring the acid on to the marble dust, instead of adding the dust to the acid, avoids the suffocating fumes of HCl, which are sure to be given off if the latter procedure is followed. After the last addition of acid filter into any convenient metal vessel whose weight is known, then boil until a drop of the liquid put on a watch glass, and cooled by placing the glass on a lump of ice, becomes solid moderately quickly, then cool by placing the vessel in another vessel containing ice and water. As the temperature falls, the calcium chloride should be stirred to prevent the formation of a compact mass not easy to break up. If the operation is properly performed, when the temperature of the calcium chloride reaches 40° F. or a little below, the material in the metal vessel will be a more or less mushy mass of crystals of calcium chloride. Remove now the metal vessel from the ice-water, wipe it dry on the outside, and weigh to determine the amount of calcium chloride. Wrap the bottom and sides of this vessel well with towels or other non-conducting material, and then for every three parts of calcium chloride add two parts of snow or finely pounded ice, and stir thoroughly. After a minute or two the material to be tested can be placed in the liquid, and the whole thing should then be covered to prevent access of heat.

2. *For chilling point*, when it is desired to know whether a liquid remains clear at any given temperature. Temperatures

from any one at which the liquid to be tested is clear down to 32° F. are easily obtained. Put a gallon of water in a bucket made of wood or indurated fibre, and add warm or colder water or ice, as the case may require, until the desired temperature is obtained, then add the bottles of liquid to be tested, taking care to keep the water the required temperature during the cooling of the liquids in the bottles by the proper additions. Temperatures from 32° down to zero F. may also be easily obtained. To a gallon of water in a bucket of wood or indurated fibre add, 15 lbs. of cracked ice. Stir thoroughly with a wooden stick, and when the temperature has reached 32° F. or thereabouts, add, with continued stirring, dry common salt, sufficient to produce the temperature desired. Approximately each quarter pound of salt added will lower the temperature under the conditions given above 2° F., until about 10° is reached, when twice the quantity must be added to bring the temperature down 2°. As the usual specified temperatures at which chilling points are observed are 32°, 20°, 10°, and zero F., it is fairly safe to say that these temperatures may be obtained as follows :—32° F.: into a wooden or indurated fibre bucket put 1 gall. of water, and any convenient amount of ice, provided only sufficient is used. 20° F.: 1 gall. of water, 15 lbs. of cracked ice, and 1½ lbs. of dry common salt. 10° F.: 1 gall. of water, 15 lbs. of cracked ice, and 3 lbs. of dry common salt. Zero F.: ½ gall. of water, 15 lbs. of cracked ice, and 5 lbs. of dry common salt. A little experience will enable the temperatures desired to be reasonably well controlled. Of course the melting of the ice continually dilutes the salt solution, and if fairly constant temperature for some time is desired, occasional small additions of salt will be needed. For temperatures below zero F., crystallized calcium chloride may be used in place of common salt. So much depends on the amounts of the materials used, and especially when dealing with such low temperatures, on the appliances, and the protection given to the vessels in which the cold is produced, that it is perhaps hardly wise to try to give proportions. It may be said, however, that 3 lbs. of finely crushed ice, and 2 lbs. of crystallized calcium chloride in a properly cooled and protected vessel, will give 10° below zero F., and 3 lbs. of finely crushed ice, and 3¾ of crystallized calcium chloride under the same conditions, will give 20° below zero F. A few experiments are worth more than a good many directions, and the principles involved seem perfectly clear.

3. *For chilling point*, when it is desired to know at what temperature flocks or scales of congealed constituents of more or less opacity takes place. Use the way of obtaining the desired temperatures described in the preceding paragraph, except that in going down the scale temperatures 5° apart are produced by the proper mixtures, aud used as described under "operations."

CALCULATIONS.

The figures involved in this method are simply readiugs of thermometers, no calculations being necessary.

NOTES AND PRECAUTIONS.

It will be observed that this method, so far as cold test is concerned, consists practically in freezing the liquid to be tested, and then taking the temperature of the thawing, mushy mass, when it will just flow from one end of the bottle to the other. It is quite well known that other characteristics of the cooling of liquids have been made use of as cold test, also other methods of manipulation have been prescribed. For example, the temperature at which flocks of congealed constituents begin to separate has been called the cold test of a liquid ; or, in other words, the liquid has been said to stand cold test if it remained perfectly clear at any given temperature. Still further the cold test of a liquid was formerly taken by putting an ounce or so in a bottle, as described above, hanging a thermometer in the centre of it, and then exposing the whole thing to cold without agitation, and observing the temperature at which the last part of the liquid or that immediately surrounding the thermometer became congealed. In view of this diversity of practice the distinctions given in the earlier part of this method seem desirable.

It is well known that most liquids whose cold test is desired contain constituents which congeal at different temperatures ; in other words, they are not homogeneous. It is also well known that when liquids made up of constituents which congeal at different temperatures are exposed to the slow action of cold, the constituents of highest congealing point solidify first, next to the sides of the bottle, provided the liquid is left undisturbed, and a little later, if the source of cold is low enough, constituents of lower congealing point solidify, and so on gradually forcing to the centre of the bottle those constituents which have the lowest congealing point. Furthermore, it is well known that the separation of constituents of different congealing points, as described above, is affected by the rate at which the cold penetrates the mass of liquid. If the rate is very slow, that portion of the liquid around the thermometer which congeals last will show a much lower figure for cold test than if the rate of cooling is more rapid. In view of these facts, it is evident that the method formerly in use—viz., observing the temperature at which that part of the liquid around the thermometer, as above described, congealed—did not give the cold test of the whole liquid, but of that constituent which congealed at the lowest temperature, and that the figure obtained was a function of the rate of cooling. It is believed that the method described above obviates these difficulties, and that with some experience and sufficient care in the manipulation, duplicate results can be obtained on the same sample, which will agree within 2° or 3°.

It will be noted that the directions require stirring and mixing of the liquid, both in taking cold test and chilling points. The object of this is to enable the cold test or chilling point of the whole liquid to be obtained, rather than that of constituents of it, as explained above. Moreover, without stirring and mixing, the whole mass would not be of the same temperature, since the thawing or access of heat in taking cold test proceeds from the outside toward the centre. It is, of course, recognized that the chilling point is affected by the agitation of the liquid during cooling ; in other words, it is probable flocks or scales separate at a little higher temperature with agitation of the liquid than if it is allowed to remain perfectly quiet. No practical method of getting the whole of the liquid cooled to the same temperature within reasonable time is known, however, except to stir and mix, and since the manipulation is prescribed, no unfairness results. It may be queried whether the amount of stirring does not have an influence, but experiments seem to indicate that if a liquid is close to the margin, any stirring will be sufficient to cause flocks or scales to separate, while if the limit is somewhat wide, considerable stirring will not bring turbidity.

With proper appliances a very large number of cold tests can be made in a day. Also chilling points to see if the liquid remains clear at any specified temperature, require no very elaborate manipulation. Chilling points to see at what temperature turbidity begins are much slower, since they require constant watching and manipulation.

PERSONALS.

Mr. W. J. McLean has been appointed District Passenger Agent of the Mobile & Ohio Railroad, with headquarters at Chicago, Ill.

Mr. W. H. Harrison has been appointed District Passenger Agent of the Mobile & Ohio Railroad, with headquarters at No. 220 Fourth Street, Des Moines, Ia.

Mr. M. H. Bohreer has been appointed District Passenger Agent of the Mobile & Ohio Railroad Company, with headquarters at No. 168 Griswold Street, Detroit, Mich.

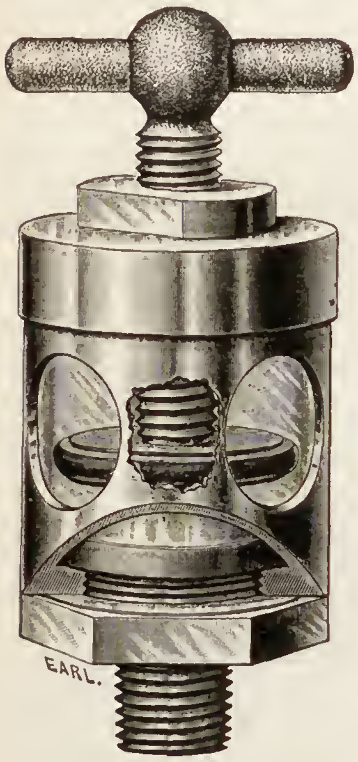
Mr. W. E. Williams has been appointed Purchasing Agent and Storekeeper of the International & Great Northern Railroad Company. He will have immediate charge of all purchases and distribution of supplies, with headquarters at Palestine, Tex.

PROCEEDINGS OF SOCIETIES.

Engineers' Club of St. Louis.—At the meeting of June 5 Mr. Bryan stated that a meeting of the local membership of the American Society of Mechanical Engineers had been held, the unanimous sentiment of which was, that arrangements be made to invite the Association to hold its spring meeting of 1896 in St. Louis, and it was thought that the movement would be strengthened by being endorsed by the Engineers' Club of St. Louis. On motion of Mr. Moore, it was ordered that the Executive Committee extend, on behalf of the Engineers' Club of St Louis, an invitation to the American Society of Mechanical Engineers to hold their spriug meeting of 1896 in St. Louis.

American Society of Mechanical Engineers.—The spring meeting of the Society was held at Detroit, Mich., from June 25–28 inclusive, with headquarters at the Russell House. The following professional papers were presented : The Old and the New, by Robert Allison ; A New Form of Sterilizer, by A. M. Goodale ; A Portable Disinfecting Plant, by W. H. Francis ; The Strength of Iron as Affected by Tensile Stress

while Hot, by De Volson Wood ; The Effect of Length of Specimen on the Percentage of Ductility, by R. C. Carpenter ; A T-Square and its Mountings, by W. A. Gabriel ; Efficiency of Boilers, by F. W. Dean ; Force Required and Work Performed in Driving and Pulling Out Wire Nails, by R. C. Carpenter ; New Forms of Friction Brakes, by W. F. M. Goss ; A H.P. Planimetre, by E. T. Willis ; A Coal Calorimetre, by R. C. Carpenter ; Tests to Show the Distribution of Moisture in Steam when Flowing in a Horizontal Pipe, by D. S. Jacobus ; Analysis of the Tremont Turbine, by DeVolson Wood ; Rustless Coatings for Iron and Steel (third paper), by Matthew P. Wood ; A Piece-Rate System, by F. W. Taylor ; The Down Draught Furnace for Steam Boilers, by William H. Bryan ; A



THE PENBERTHY GREASE-CUP.

New Shaft Governor, by E. T. Armstrong ; A Method of Proportioning the Cylinders of Compound Engines, by E. C. Knapp ; Expansion Bearings for Bridge Superstructures, by George S. Morison ; Tests of the Experimental Engine of Sibley College, Cornell University, by R. C. Carpenter ; Tests of a Combined Electric Light and Electric Railway Station, by D. C. Jackson ; Pipe-Covering Tests, by George M. Brill.

With the reports of professional committees at the Wednesday morning session there was presented and discussed two papers by Mr. W. J. Keep, of Detroit, Mich., member of the Society, contributed as monographs upon subjects forming part of the work of the committee of the Society upon Standard Methods of Tests and Testing Materials. One is entitled Transverse Strength of Cast Iron, and the other is entitled Keep's Cooling Curves, and the Molecular Changes in Metals due to Varying Temperatures. The social features of the meeting consisted of an excursion to Belle Isle Park and a drive around the same, a lunch on the roof garden of the new Chamber of Commerce Building, a full-dress reception at the Detroit Club, and a trip to Lake St. Clair and the St. Clair River, with a fish supper at the St. Clair Flats.

Manufactures.

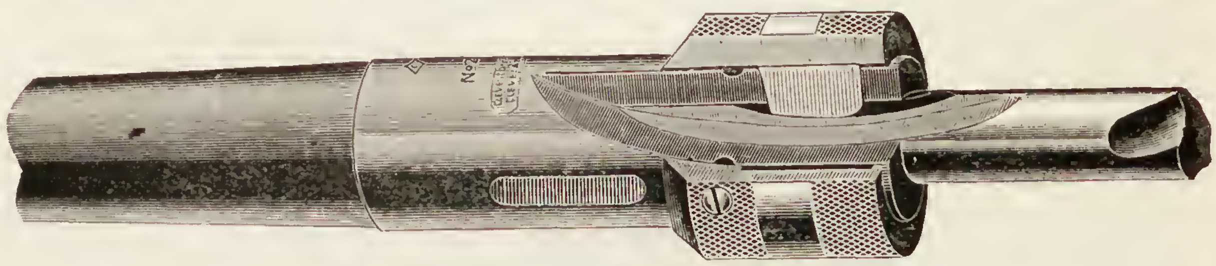
PENBERTHY GREASE-CUP.

The peculiarity of this new grease cup, which has recently been brought out by the Penberthy Injector Company, of Detroit, Mich., is, first, that the body consists of a glass cylinder surrounded and protected by an outer brass shell with openings on four sides, through which the user can see at a glance the amount of grease or "dope" in the cup, and know when to refill it, so that the journal where it is used never need be dry unless through carelessness. The plunger by which the grease is forced out from the bottom of the cup is made of a heavy rubber washer, protected on both sides by a brass disk, the whole being attached to the bottom of the stem in such a manner that the stem revolves without turning the washer or disks, and at the same time no grease can pass up through the centre of the washer. The cover never needs to be removed from the cup, as the body of the cup is screwed on to the shank and is removed from the shank to be refilled ; therefore there is no chance for any of the parts to be lost or mislaid when the cup is being filled. This cup has met with much favor when it has been used, and the makers report large orders received, although it has been in the market but a short time.

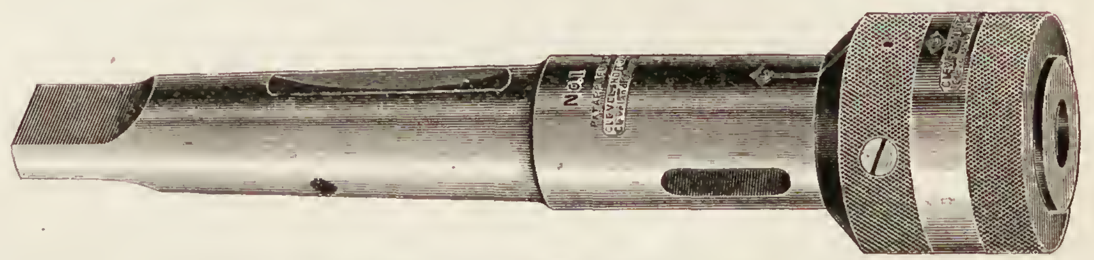
DRILL GRIP-SOCKET.

This grip-socket is designed to hold and drive taper shank drills and other tools. A groove which is an arc of a true circle is milled in the shank of the drill or tool, as shown in the sectional illustration, a key let into the body of the socket fits into the groove, and is locked securely in place by a turn of the revolving internally eccentrically counter-bored collar.

After the key is locked it is impossible for the tool to slip in



Section cut away to show grip of key on the shank.



Sockets as turned out by the factory ready for use.

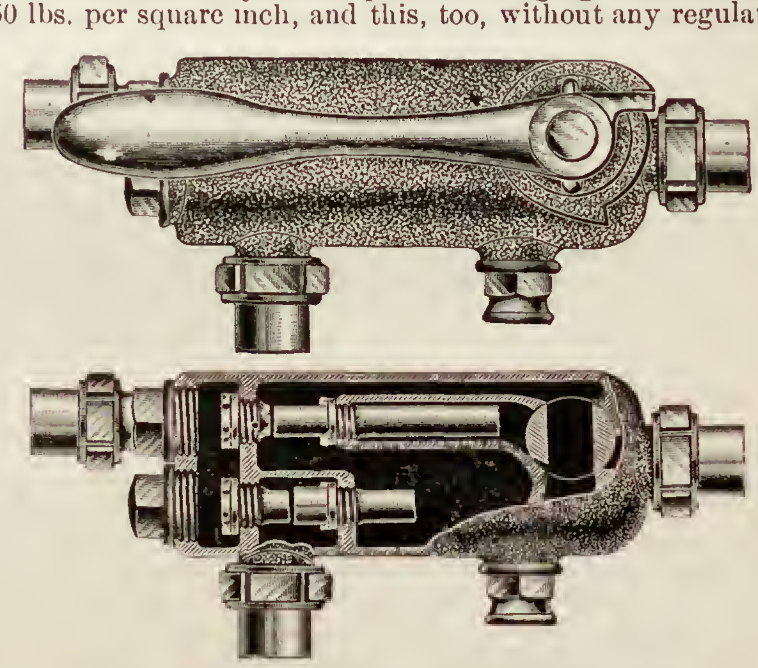
DRILL GRIP-SOCKET.

the socket or to be pulled out until the collar is turned back again to release the key. The end of the collar is bevelled, and a plain index mark on it and on the body of the socket shows when the key is released.

Drills or tools that have had the tangs on the shanks twisted off can be used in these grip sockets successfully, and in this way the cost of the sockets can be saved many times annually. Boring bars for under cutting can be used without any danger of their pulling out of the sockets, and the labor and expense of turning over heavy pieces saved.

THE BROWNLEY DOUBLE-TUBE INJECTOR.

The engravings given herewith show the external appearance and the section of the Brownley double-tube injector that has recently been placed upon the market by E. F. Keating, of 455 Water Street, New York. The peculiarity of this injector is that it is double-tubed and valveless, and that it will work under any steam pressure ranging from 15 lbs. to 350 lbs. per square inch, and this, too, without any regulation



THE BROWNLEY DOUBLE-TUBE INJECTOR.

and without breaking. It is also claimed that it will lift the feed-water 3 ft. when the temperature is 156° F., and that it will raise it 22 ft. when the temperature is 130°.

As will be seen from an examination of the engravings the device is a very simple one. The steam inlet is one size

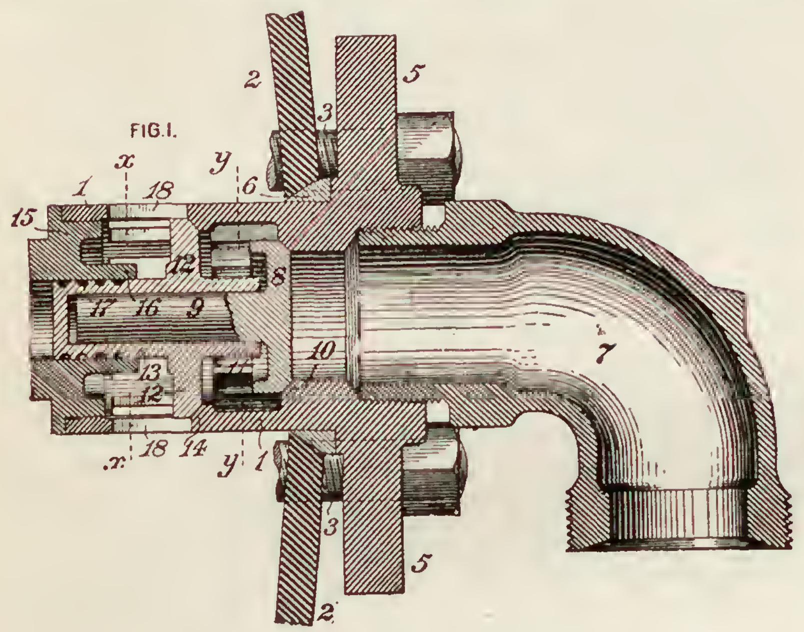
smaller than the suction or the delivery, which is said to give very economical results in the consumption of steam. For starting the injector it is merely necessary to open the steam cock, when water will appear at the overflow ; the cock is then turned by means of the lever shown, when the water will be fed into the boiler. No variation of steam pressure at any point from 350 lbs. down to 6 lbs. will cause any loss of water at the overflow. A test has been made in which the foreman of the Manhattan Elevated Railroad found that the Brownley would throw about 33 per cent. more water than the standard injector. The simplicity is such that the makers assert that any mechanic can take one apart and put it together in five minutes.

The injector for locomotive purposes is slightly varied from the ordinary one in form, so that it can be put on where others have been previously used, and is so constructed that no jarring or shaking to which it may be subjected while running will cause it to break.

Recent Patents.

CHECK-VALVE.

Taylor W. Heintzelman, of Sacramento, Cal., has patented the two forms of check-valves shown by figs. 1 and 2. It will be seen that in each case there is a valve inside of the boiler which will close and prevent the escape of hot water



HEINTZELMAN'S CHECK-VALVE.

and steam in case the valve is knocked off by accident. The construction of these valves will be apparent from the engravings without description. The patents are numbered 537,038 and 538,831, and are dated April 9 and May 7 respectively.

STEAM SEPARATOR.

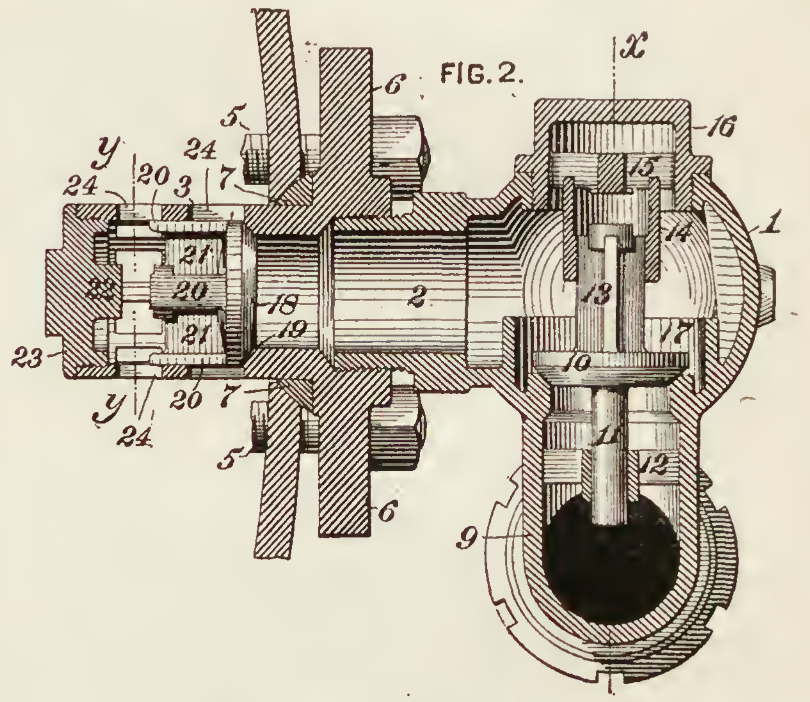
An inventor with the aliterative name of Jules John Joseph De Rycke, of Brooklyn, N. Y., has patented the arrangement shown by fig. 3. This represents a section of an ordinary locomotive dome and steam space over the fire-box. D is the throttle-valve of the ordinary construction, B the dry-pipe, which projects upward inside of an enlarged vertical pipe, C, and which has an annular space, C', between the two. E is a deflector with conical wings, and which is held in a fixed position by the shaft E^3 and a stop, c. C^2 is an extension of C, which communicates with the annular space C^1 and C^4, a valve which is opened and closed by the bell-crank F, rod H, and throttle-stem G, which is operated by a throttle-lever of the usual kind. C^5 is a check-valve attached to the end of the pipe C^2 to prevent water and steam from flowing into C^2, but which opens whenever the pressure in the annular space C^1 exceeds that in the steam space above the surface of the water.

The operation is as follows : The steam enters the dry-pipe through the throttle in the usual way. In passing downward in the pipe C it encounters the helical wings E^1, which gives the steam a rotary movement, and the centrifugal force carries the heavier particles of water outward, so that they are brought in contact with the inner surface of C, and then pass downward and are drained off through the pipe C^2.

The patent is dated May 28, and is number 539,859.

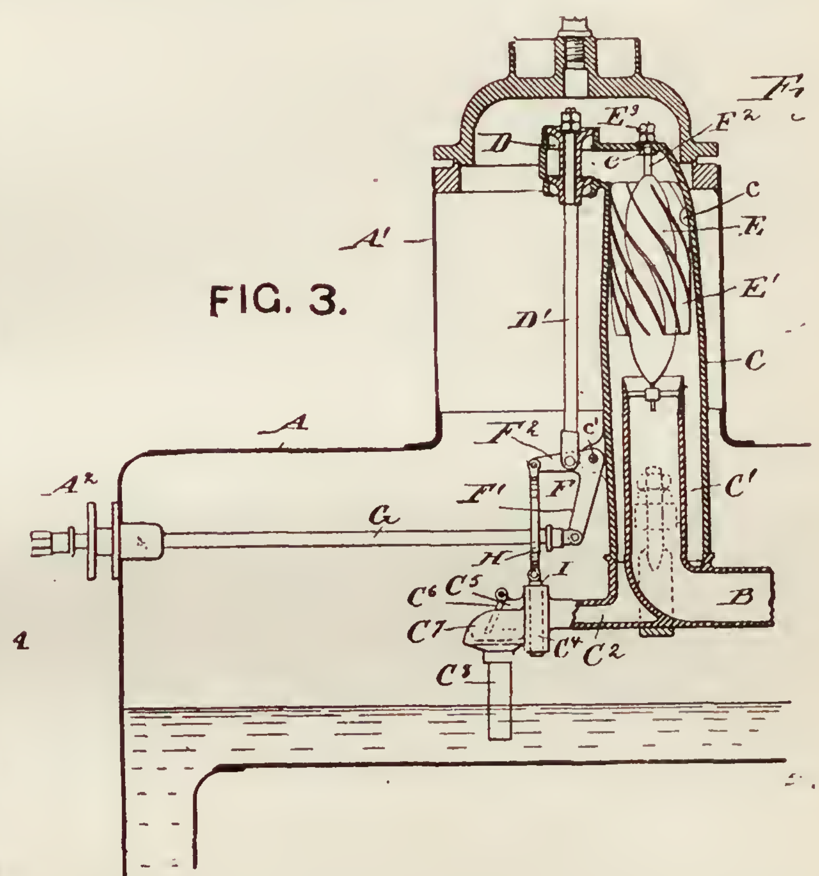
COMBINED TUBULAR BOILER AND SUPERHEATER.

In the American Engineer for February of this year (p. 89) a description was given of Schmidt's boiler, and of some remarkable results which were attained in tests made



HEINTZELMAN'S CHECK-VALVE.

with it in Germany. In our issue for April, p. 192, extracts from a patent taken out by him were published. Another patent has just been issued to him, in which he describes



DE RYCKE'S STEAM SEPARATOR.

some improvements in his invention. Notwithstanding the length of this description, our readers, we think, will be repaid for reading it carefully :

" Before entering into the details of the mode of construction of my improved combination shown in the drawing (fig. 4), I think it necessary to give some preliminary statements and explanations, in order to render the idea of the invention perfectly clear and intelligible.

" If steam is to be superheated to a temperature of about 300°, the heating gases should have, as is well known, a temperature of at least from 500° to 600°. The said former temperature will be reached best by arranging the superheater above the steam generator, and exposing it to the furnace gases of the same ; or, in other words, by arranging the superheater behind the steam generator with regard to the direction of the furnace gases of the latter, and exposing it to a zone of

said gases, in which the temperature amounts to about 600°. The fire gases need thus be cooled down by the boiler proper but to about 600°, while generally, in a steam generator without superheater an exhaust of the heat down to 250° is required. As is well known, however, the greatest part of steam is generated in the fore part of a boiler, the remaining part, that is generated by exhausting the heat from 600° down to 250°, being of but small quantity, and necessitating comparatively large heating surfaces. Extended trials made with locomotive engines have proved that about 50 per cent. of the whole of the steam is generated in the small part surrounding the fire-box. It results from this that when arranging a superheater for temperatures of about 300° above or behind a steam generator, the latter not only may have a comparatively small heating surface, but should have such a one; and it will be seen, further, that such boiler with superheater will yield at least the same effect as a larger boiler that consumes a like quantity of fuel, since the furnace gases of both boilers are exhausted in like degree—*i.e.*, are escaping into the smoke-stack with the like low temperature. Owing to these facts, now, the boiler or generator employed in my improved combination is composed of coils or coiled pipes. These latter offer, in themselves, certain advantages for every boiler plant. They could, however, not be employed in a more extensive degree, especially for large plants, as there arise in the practical use of them serious drawbacks difficult to be overcome, as will be shown in the following.

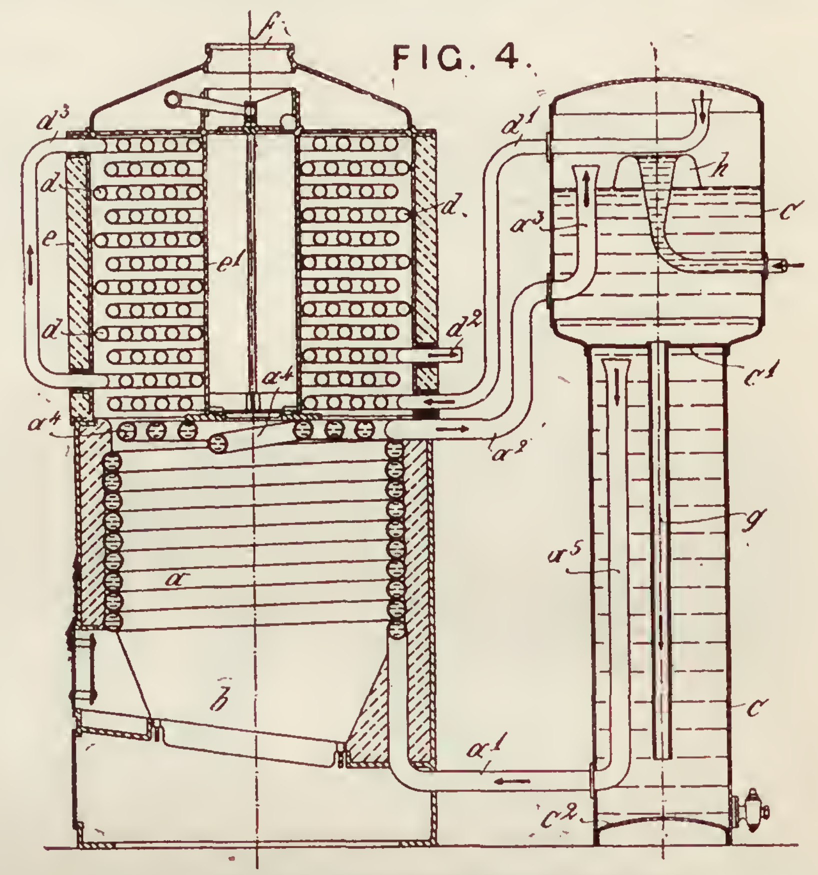
The main point to be considered in the use of coiled pipes as steam generators consists in the rapid circulation of the water or of the mixture of water and steam within the coil. Such circulation is indispensably requisite. The same is considerably hindered or delayed, however, by the great friction arising between the water and the inner walls of the pipes, especially if the latter are of a somewhat great length and of but small inner section. This disadvantage could be overcome, seemingly, by using pipes with larger section. This section, however, necessitates dimensions of such size that it is nearly impossible to bend such pipes. A perfect change, however, in all these circumstances occurs, if the tubular boiler with coiled pipes is combined with a superheater. There is no necessity any more for providing so large a heating surface for properly exhausting the heat of the fire or furnace gases, but a boiler of but the fifth or sixth size with coils of but small section will be sufficient for delivering the desired effect, even if a larger number of H Ps. is required. The heat of the fire need not be cooled by the heating surfaces of the boiler proper down to 250°, as this is performed by the superheater; and the generation of steam will be a regular one and free of shocks, as the circulation of the water, or of the mixture of water and steam respectively, within the short coil with its small section is a very active one. The best effect, however, of the combination of a tubular boiler (with coiled pipes) with a superheater is attained by arranging a reservoir between the boiler coil and the superheating coil, for the purpose of separating water and steam. I have represented this arrangement in the accompanying drawings (fig. 4), in which is shown a vertical section through the tubulous boiler, the superheater, and the said reservoir.

"The coil *a* of the tubulous boiler, which is heated from the furnace *b*, is connected by its two ends a' a^2 with the reservoir *C*, coil end a' terminating into the lower compartment of the reservoir by the mediation of a bent tube a^5 extending upward within said compartment; coil end a^2 terminating into the upper compartment of the reservoir by the mediation of a bent tube a^3 likewise extending upward within that respective compartment. The further details of the reservoir will be more fully described hereinafter.

"The uppermost portion of the reservoir forms a steam dome, and the saturated steam is led from that dome by the mediation of pipe d' into the superheating coil *d*, from which the superheated steam is led away by pipe d^2. The feedwater for the boiler, or for coil *a* respectively, enters the latter through the pipes a^5 a', and leaves the coil, after being heated and partly turned into steam within the same, by the pipes a^2 a^3. The mixture of water and steam separates within the upper compartment of the reservoir *C*, the steam collecting within the dome, the boiling water mixing with the feedwater and heating the same.

"The superheater consists of a number of superposed flat horizontal coils, which are connected with each other to a continuous passage. This connection of the coils, however, is made in such a way that two divisions are formed out of them; the first division, next to the boiler-coil, being passed by the steam in a direction like that of the furnace gases; the other division being passed by the steam in the opposite direction—that is to say, opposite to the direction of the furnace gases. Both divisions are connected by the bent tube d^3. The said superheating coils are arranged in the annular space between the outer wall *e* and the inner wall e'. The furnace gases coming from the fireplace *b* are led through the said space, and leave the whole apparatus at *f*. It will be seen now that the circulation of the water, or of the mixture of water and steam respectively, within the boiler coil will be a very intense one, as, first, the said coil is but short, and has but a small section; and as, second, the contents of coil *a* are constantly under the pressure of the water column within the lower compartment of reservoir *C*. The generation of steam is, therefore, a very intense and rapid one, as well as free of shocks, and the steam then enters the superheating coils without the least addition of water, as the latter is perfectly kept back by the reservoir. The water now circulates again and again through the boiler coil, so that the whole of the water within reservoir *C* is heated to a high degree of temperature. This circulation will, as a matter of course, be the more active the greater the difference in pressure between the water column within the lower compartment of the reservoir, and the water and steam column within the boiler coil; and, further, the less the resistance offered by the friction

FIG. 4.



SCHMIDT'S COMBINED TUBULAR BOILER AND SEPARATOR.

between the said water and steam column and the inner walls of the boiler coil. It results herefrom that the whole of the water contained within, or entering, the said boiler coil cannot be turned into steam at so rapid a circulation, and it becomes thus necessary to provide the reservoir *C* for separating both parts of the water and steam mixture leaving the boiler coil, as but the steam can be permitted to enter the superheating coil, while the hot water must remain.

"Concerning now the special construction of the reservoir, the latter is divided into two superposed compartments by a horizontal plate C' having secured to it a vertical tube *g* extending downward to the neighborhood of the bottom C^2. The vertical tube a^5 communicating with end a' of the boiler coil is arranged in the same compartment of the reservoir, and extends upward to the neighborhood of plate C' aforementioned. The purpose of this arrangement is to separate and precipitate sediments and the like contained in the feedwater, for preventing the boiler coil from becoming incrustated. The feedwater enters the upper part of the reservoir through the funnel *h*, and the sediments separated by the heating of the water flow, together with the latter, down into the under compartment of the reservoir through tube *g*. The water, then, in order to enter the opening of tube a^5 flows upward again, while the sediments remain back and precipitate on the bottom C^2.

"The uppermost part of the vertical boiler coil *a*, or that part situated between the coil *a* proper and the pipe a^2, is formed to a horizontal coil a^4, the purpose of which is to break the intense heat discharged by the fire, so that the superheater is prevented thereby from becoming pervious."

Mr. Wilhelm Schmidt, of Wilhelmshöhe, Germany, is the inventor, and his patent is dated May 28, 1895, and numbered 539,827.

AERONAUTICS.

UNDER this heading we shall hereafter publish all matter relating to the interesting subject of Aerial Navigation, a branch of engineering which is rapidly increasing in general interest. Mr. O. Chanute, C.E., of Chicago, has consented to act as Associate Editor for this department, and will be a frequent contributor to it.

Readers of this department are requested to send the names and addresses of persons interested in the subject of Aeronautics to the publisher of THE AMERICAN ENGINEER.

THE PROPOSED FRENCH CAPTIVE BALLOON.

IN the catalogue and price list of balloons and aeronautical materials, recently issued by Messrs. Louis Godard, Ed. Surcouf & J. Courty, aeronautical engineers and successors of the late Gabriel Yon, we find further data concerning the giant captive balloon which these gentlemen propose to build for the French International Exposition of 1900.

It is proposed to make this 144 ft. in diameter, to hold 1,600,000 cub. ft. of hydrogen gas, and to lift 160 passengers at once. It is to be equipped so as to permit ascensions to a height of 3,280 ft.

It will be remembered that the largest captive balloon hitherto built, that of Giffard in 1878, was 118 ft. in diameter, contained 860,000 cub. ft. of gas, and was equipped to rise to 1,500 ft. The new balloon, therefore, will have so much greater lifting power as to admit of strengthening all the parts to a much higher factor of safety, so as to make it safe against the highest winds. It is estimated that it can be operated at least nine days out of ten, even during windy weather.

The balloon skin is to be composed of four thicknesses of a special silk tissue, with a coefficient of resistance, both in the direction of the warp and the woof, of 1,200 kilograms per lineal metre (805 lbs. per lineal foot), united together by a special varnish which increases the resistance, so that the combined skin will exhibit a strength of 5,000 kilograms per lineal metre, or 3,353 lbs. per lineal foot. It is calculated that in a wind of 45 miles per hour the external pressure on the balloon can be compensated by an internal pressure equivalent to eight-tenths of an inch of water, and that the skin will then be strained to only one-twenty-third part of its ultimate resistance.

This calculation, however, is based upon the assumption that the resistance of a sphere is 20 per cent. of that of a plane equal in area to its mid-circle, while we know of some experiments which show twice this coefficient.

In order to maintain the internal pressure requisite to compensate for the wind, for variations of temperature or for the height attained, without loss of gas, an internal bag or air balloon, of one-seventh of the total cube, is kept more or less inflated with air pressure, so as to compress more or less the gas in the balloon, and thus keep the skin uniformly distended and to preserve the spherical shape at all times. The air balloon is to be provided with an automatic valve set to open at a pressure slightly less than the hydrogen gas valve of the main balloon, and thus, whenever the internal pressure increases from any cause, air runs to waste instead of gas.

The netting is to be made of hemp dipped in a preparation of india rubber, and the points of junction of each mesh are to be shielded with a light strip of leather to prevent abrasion of the balloon skin. There are to be 384 meshes at the circumference, and 768 lines forming the net, with a breaking strength of 1,200 kilograms each, whence it is calculated that the total resistance is equal to 900,000 kilograms, or 1,980,000 lbs. against a vertical pull. This netting is concentrated by means of *pattes d'oies*, or reducing meshes, into 48 suspension cords, which attach to the main circle, from which the car is suspended, with the intervention of a dynamometer.

The main cable is to be of extra selected hemp, and to measure 5 in. in diameter at the balloon and 4 in. in diameter at the ground, this tapering shape being adopted to insure that rupture, should it occur at all, shall occur near the ground, so as to avoid the danger from a cable falling from overhead, and to have the balloon loaded with a long guide rope in the improbable contingency that it should get away. The strength of the cable is calculated at 90,000 kilograms (198,000 lbs.) at the top, and 60,000 kilograms (132,000 lbs.) at the bottom.

The car is to be annular in shape, with an exterior diameter of 33 ft., and an internal diameter of about 20 ft., thus forming a circular gallery 6½ ft. wide, capable of accommodating 160 passengers. The floor area is to be 540 sq. ft., and under this are placed various receptacles for the tools and supplies. The ballast is to be stored under a circular bench, on which the passengers are to sit.

As already intimated, a dynamometer intervenes between the suspension cords and the main cable. This enables the aeronaut to know at all times what the lifting power is, and to regulate the vertical traction of the balloon upon its cable with regard to the wind, so that the corresponding angle shall not exceed 45°.

The main cable passes from the dynamometer under a main pulley attached by a universal joint to a strong frame of wrought and cast iron, and is thence led to a drum upon which it is wound by a double steam engine of 600 H.P. This consists of four cylinders, coupled in pairs, with cranks at right angles with each other, and the speed is to be such as to admit of three ascensions and returns per hour. When ascending, the balloon serves as a motor and operates upon the cylinders, which are provided with air pipes so as to serve as regulating brakes by acting as air pumps. There is to be, moreover, an automatic safety brake operated by air.

The total cost of the plant is estimated at $200,000, and it is expected to be able to operate for 160 days out of the 200 that the Exposition is to last. The receipts during that period are estimated at $800,000, from which should be deducted the operating expenses, but probably leaving a profit besides paying for the plant.

The scheme seems to have been devised with great care to ensure safety, and with the experience that the public of France has hitherto had of the small danger incurred in such ascents, together with the magnificent views to be obtained from a balloon in the unsmoked air of Paris, it seems probable that the enterprise will prove a great success.

HIGH BALLOON ASCENSIONS.

IN AERONAUTICS for December, 1893, and again for March, 1894, there were given accounts of the high ascensions of the balloon *Aerophile* from Paris on March 27,1893. In this JOURNAL for January, 1895, an account was published of the ascension of *Cirrus* from Berlin on July 7, 1894.

In the *Zeitschrift für Luftschiffahrt* for February and March of the current year there is a very interesting account of a triple balloon ascension from Berlin on September 6th, 1894. It is understood that all these records will shortly be published in book form, and that is the reason we have now only a short outline of the observations. Too much praise cannot be given for these attempts to explore the upper air, and we may hope that such exploration may become much more systematic, both abroad and in this country.

On September 6 the balloon *Cirrus*, 8,760 cub. ft. capacity, was inflated with coal gas and liberated at 8.45. Its course was east northeast, and it quickly disappeared from view. Nothing more was heard of it till the last days of September, when it was found in Russia, not far from Wilna. The principal figures that have been published will be found at the end.

Four minutes later the *Phœnix* (70,600 cub. ft.) was liberated, with Professor Berson and Assistant Becker on board. The highest point reached was at 1.30 P.M., about 20,190 ft. The temperature at starting was 59° F., and at the highest point it was −15° F. At the time of the lowest temperature that at the earth's surface was 65°, and this would give a diminution of 1° F. in 252 ft. A similar computation for *Cirrus* gives 1° in 409 ft. It is impossible to explain this apparent discrepancy, but I do not think it due to a vastly less diminution with height at the higher levels.

Very soon after the *Phœnix* was liberated the balloon *Majestic* (106,000 cub. ft.), with three men on board, was released. This balloon arose only 3,600 ft., and no observations are given. In the accompanying table I have grouped together some of the more interesting facts brought out in the three very high ascensions. The formula used for computing the height of a balloon is that of Professor Ferrel. It is quite a pity that every one making these computations and publishing heights uses a different formula. For example, in the recent *Cirrus* ascension Ferrel's formula gives 61,350 ft., Professor Berson gives 60,531 ft., and the Smithsonian formula gives 59,670 ft. There ought to be some common understanding about this matter. Professor Ferrel's formula is undoubtedly the most accurate up to his time, and I have tables computed from it up to 75,000 ft. As a matter of fact, we have no accurate knowledge of the reliability of the barometric formula

much above 10,000 or 15,000 ft. It would be of the greatest interest if a large astronomical telescope could be turned upon an ascending spherical balloon, and its diameter measured with a micrometer at frequent intervals. It is also proposed to take up a camera and photograph the earth at various points as we ascend. Mr. Jewell, of Baltimore, has suggested that for this purpose there must be used an universal level, so as to determine when the camera is exactly vertical. A few accurate checks upon the barometrically computed height of a balloon up to 25,000 or 30,000 ft. would be invaluable at the present time.

RECORDS BROUGHT BACK BY HIGH BALLOONS.

Name.	Date.	Place.	Capacity	Temperature. Sea Level.	Temperature. Highest Point.	Height.	Direction.	Distance.	Velocity of	Temp. Diminution.
			cu. ft.	F.		Ft.		mi.	m. per hour.	1° in.
Aerophile.	Mar. 27, 1893.	Paris.	4,000.	63	[−104]	52,280	E.S.E	78	12	313
Cirrus.	July 7, 1894.	Berlin.	8,760.	63	[−86]	54,530	S.S.E	622	62	366
Cirrus.	Sept. 6, 1894.	Berlin.	8,760.	59	[−89]	61,350	E.N.E	560	83	409

In the last ascension the enormous velocity of 83 miles per hour is extremely interesting. This was at an height of about 59,000 ft. At about 15,000 ft. Professor Berson found a velocity of 38 miles per hour, and his whole trip of 7 hours 6 minutes gave an average velocity of 17 miles per hour from start to finish. H. A. HAZEN.

April 30, 1895.

LONGITUDINAL STABILITY IN AERIAL NAVIGATION.

To the Editor of THE AMERICAN ENGINEER AND RAILROAD JOURNAL :

SIR : It is scarcely possible to overrate the importance of automatically obtaining longitudinal stability in aeronautic experiments. We are seeking to substitute an inanimate machine for the living animal. When a man walks, he is continually poising himself on one leg, and he does not fall because he has become so well practised in the art that he keeps his balance automatically, without giving the subject a thought. If we were to attempt to make a mechanical man walk, he would immediately fall. The mechanical man would require a substitute for the brain of the living man, and the substitute must necessarily be mechanical. The bicyclist supplies another illustration of this fact. A mechanical bicyclist is an impossibility. As a man in walking keeps his balance from long practice, so the bird keeps its horizontal position by the constant use of the tail. The bird appears to do this with so much ease that an observer is apt to conclude that no mechanical action is necessary ; but this is a mistake. Just as a man, while walking or on a bicycle, continually moves to the right or left to prevent his falling by means of prompt, instantaneous action, quite unconsciously, so the bird secures its horizontal position.

The object of my invention is to supply this prompt action by means of the inverted pendulum, so mounted that the slightest departure from the horizontal immediately applies an independent power to the correction of the angle of incidence. A very small motive power is required for operating the rotating shaft, and this small power is a mere trifle compared to the loss which is incurred when an aviator in motion deviates from the horizontal to any great extent.

I regret that in the description of my device for steering, inserted in your March number, the curved arrow was placed on the wrong shaft by mistake ; it should have been attached to the shaft 8.

Yours truly,

THOMAS MOY.

HIS FIRST PARACHUTE DROP.

THE Philadelphia *Times* recently published the following account of how a person felt on jumping from a balloon for the first time. Most of our readers will probably agree with us in thinking that as a piece of imaginative reportorial writing it is tolerably good.

" The great balloon which was to bear me on my first journey up into the azure heights, and from which I was to make my maiden leap with a parachute, was tugging at its moorings upon the broad lawn. I confess that it was with some nervousness I took my seat in the little car beside Joseph Norcross, a skilled aeronaut, who had from dizzy heights made many and many a flight earthward through the air. With this same balloon he had during the past year safely made 67 ascensions, and had each time successfully descended with the parachute. So why should I fear ?

" Norcross smilingly welcomed me, and as he gave the order to cast loose the line and the men on the ground released the great aerial traveller, I felt myself afloat in a little boat upon an ether sea. There was no sudden jolt or jar about it, so cleverly was the release effected. Putting my head over the side of the car, I looked below and was surprised, for apparently we were not ascending, but the great world, with all her glory of green and gold, was dropping from us away down into space. I looked in pleased amazement upon the wonderful panorama presented as the earth kept receding. Norcross smiled.

" Then I gazed upward at the great birdlike balloon soaring triumphantly on. Again I looked down, and the houses and barns seemed to crouch closer to the ground and the villages to cluster together. Streams and lakes at last looked like mere threads or blots of silver. Away in the north the range of mountains looked like an emerald wall, while that dark blur on the earth below was the thriving and populous county seat. We were far from the world. Suddenly we were in a cold, drizzly rain, and the earth was shut from view. I inquiringly looked at Norcross.

" ' We have entered the clouds,' was his smiling explanation, ' and we are not yet a mile high.'

" In five minutes we emerged into beautiful sunshine. Beneath us lay a heavy bank of fog burnished by the ardent afternoon sunlight, but the earth for a time was not within sight. Suddenly, through a rift in the clouds, I caught a glimpse of it far, far below. So distant was it that only here and there could an object on its surface be discerned. Truly we were getting well up in the world. The thought at once attracted my serious attention to the balloon. Suppose it should spring a leak or collapse, what would be the fate of the daring sky travellers ? Or, on the other hand, if the valve line failed to operate, would we go on upward forever ? The thought disturbed me not a little. The aeronaut surmised what was passing in my mind, smiled genially, and said :

" ' I have made a thousand ascensions unharmed. From what height would you like to leap ? '

" ' Make it about 1,000 ft.,' I replied, determinedly.

" ' All right,' Norcross responded, as he scanned the aerometre and promptly pulled open the valve, preparatory to descending.

" Placing my hand out over the side of the car the rush of cold air against my downturned palm indicated that we were again swiftly journeying earthward. Soon we were enveloped in the fog of the cloudbank for a minute or two, and then emerged with the distant earth in view. The glance at it from my perch there away up near the clouds only increased my nervousness.

" ' Look up ! look up ! ' exclaimed the aeronaut, ' or you'll lose your nerve.'

" A glance downward when descending with the parachute might, I knew, turn my hair white or bring on a stroke of paralysis, as it had done in the case of some other men.

" ' Twenty-five hundred feet from here to the ground,' exclaimed the smiling Norcross. ' Get ready.'

" He then bound round my body under the arms a stout rope, the other end of which was secured to the trapeze bar in my hand, which bar in turn was attached to the parachute that hung at the bottom of the car.

" It was now rapidly approaching the time when I should make the leap of my life, and, grasping the guy ropes of the car, I stood upon the seat in readiness, while Norcross gave me his final instructions.

" ' Leap as far out into the air as possible, and the tightening of the trapeze line will release the parachute, which will open its 15-ft. spread in a second or two,' he said ; ' then all you've got to do is to look up and hang on.'

" ' Twelve hundred feet,' shouted Norcross. I tightened my grasp on the trapeze bar, looked steadfastly upward, and awaited the word to leap. It was the most trying time of my life, but I was determined to make the jump.

" ' Go ! ' suddenly exclaimed the aeronaut. Closing my eyes, I made a great leap out into space, and could feel myself rapidly shooting downward. Then the trapeze line tautened with a slight jerk that indicated the release of the closed parachute, and I looked up just in time to catch a flee-

ing glimpse of Norcross's smiling face peering over the side of the car far above me. But the parachute did not open. The seconds passed into a minute, and then into three, four, five minutes. Would the parachute never open? Must I be dashed to death on the ground 1,000 ft. below?

"Suddenly there came a sharp click from above, and my speed perceptibly slackened. Ah, the parachute had opened! My life was saved! With an intense feeling of satisfaction I felt myself deliberately descending, and, looking about, though not directly beneath me, took in the scenic beauties of my journey on every hand. But there came over me a grave fear. Suppose in my descent I should strike the top of a church steeple or one of the many chimneys with which that section of the country abounded. Common sense, however, came to my rescue.

"Norcross, I felt convinced, knew his business, and had the balloon directly over a clear space when I made the leap, so where was the sense of such foolish fears and baseless apprehensions?

"Finally I mustered courage and looked directly below. The earth was approaching rapidly. The fences, trees, houses, and barns became more and more clearly outlined, and roofs seemed to rise directly out of the ground. Horses, cattle, and men rose rapidly from pigmy proportions to their normal size. I saw that I would land in a broad pasture field about half a mile from where we had ascended, and there was not a chimney, roof, or tree within 100 yds. There was nothing to fear.

"I saw a crowd of men and boys hastening toward the field to welcome me. Then, a few seconds afterward, to my delight, my feet struck the ground, and the most thrilling journey of my life was ended.

"Calmly I folded the parachute and then looked up for the balloon. I saw it gracefully sinking to the earth in an adjoining field, and a few minutes later had the satisfaction of receiving the hearty congratulations of the aeronaut, who told me, to my great surprise, that the parachute opened within three seconds after I leaped."

EFFICIENCY OF WINDMILLS.

In a paper by Mr. John A. Griffiths, published in the Minutes of Proceedings of the Institution of Civil Engineers, the results of some experiments on windmill efficiency are given. The mills in question were used for pumping water in Queensland. The first has a conical sail-wheel of 223 sq. ft. area, with a reefing vane, and operates a pump having a plunger 5 in. in diameter by 6¾ in. stroke. With a wind velocity of 4.3 miles per hour, this mill developed .018 H.P., which was increased to .98 H.P. when the wind rose to 7 miles per hour. Another mill, with a "solid" wheel 11 ft. in diameter, gave .011 H.P. effective with a wind velocity of 5.8 miles per hour, and .025 H.P. with a wind velocity of 6.5 miles per hour. A third "solid" wheel 16 ft. in diameter, fitted with an automatic rudder, gave .024 H.P. with a 6-mile wind. The fourth mill has a folding sail 14.16 ft in diameter, and gave .065 H.P. with a 7-mile wind; and another similar but smaller mill, having a wheel 10.16 ft. in diameter, gave .028 H.P. effective with an 8-mile wind. The sixth wheel has a 9.83 ft. turbine wheel, and gave .012 H.P. effective with a 6-mile wind. As a general result, the best efficiency of the mills was about 12 per cent. of the total energy in the wind.

PHOTOGRAPHS FROM A KITE.

Mr. William A. Eddy, the indefatigable kite-flyer of Bayonne, N. J., has succeeded in making photographs with a camera attached to the string of his tandem tailless kite apparatus. The method of doing this was fully described in an article written by Mr. Eddy and published in the New York *Herald* of June 16. The shutter of the camera was "snapped" by a string attached to it; but this method was very uncertain. Of this method of making pictures, Mr. Eddy says:

"It seems to me that the kite string camera will be useful, when improved, to map the position of an enemy in time of war, when strong winds would blow a captive balloon down sideways and endanger the photographer. By means of the kite string it is now possible to look from a great height without danger to life and without the expense of a balloon ascension. It is a characteristic of all first experiments that many improvements are to be made, many difficulties to be overcome, and the experiments will continue with every present indication that successful pictures will be taken during the present summer. If we can practically place the human eye at the height of the Eiffel Tower it will seem to foreshadow the advent of aerial navigation, when men will travel aloft, where Professor S. P. Langley has already sent an automatic motor machine without human guidance."

BORNSTEIN'S WIND-MEASURER.

In a paper describing several apparatuses for measuring the pressure of wind, the author states that the one which gives the most accurate results is that of Professor Bornstein. This apparatus consists of a light, hollow ball fixed on the top of an axle, the bottom end of which rests in a ball-and-socket joint. An arm is fixed to the joint, which extends below to the measurement-room, and by means of a good transport mechanism registers the wind pressure on a strip of paper moved by clockwork. In addition a side-lever is provided, which by means of balance weights will denote the absolute pressure at any required time.

The author states that most appliances for obtaining the wind-pressure register only the speed, from which the pressure is calculated, the results obtained giving varying amounts, according to the formula used; but with Bornstein's apparatus the pressure is registered directly on the paper, and it also registers with great accuracy the pressure of single gusts of wind. The chief disadvantage of this apparatus lies in the fact that the same instrument will not register with sufficient accuracy a pressure of a few grams and one of several kilogrammes, and it is thus necessary to have two or more appliances at the same place.

The paper is accompanied by a plate containing sketches of Bornstein's apparatus and several other wind measurers.—*Verhandlungen des Vereins für Eisenbahnkunde*, 1894.

A LILIENTHAL APPARATUS IN DUBLIN.

Professor Fitzgerald, of Trinity College, Dublin, lately purchased from Herr Lilienthal one of his aerial soaring machines, to be exhibited as one of the attractions at a forthcoming bazaar in aid of a hospital.

The machine consists of an aeroplane about 24 ft. across by 8 ft. in breadth, with a tail composed of four small fans, and is intended to glide downward against the wind when mounted and directed by an operator, in the same way as in the experiments of Herr Lilienthal, which are probably well known to our readers.

The first experiments occurred in the college grounds on April 2, in the presence of many students and spectators. They are thus described by the *Dublin Telegraph* of April 3, 1895:

"It was a quarter past one exactly when the professor, doffing his coat, prepared for his task. The preliminaries were simple. Eager volunteers at the word of command raised from the ground the machine—which is 24 ft. long and 8 ft. wide—and placed it *in situ*—that is, they gently lowered it over the professor's head and shoulders, till the same appeared through a square aperture in the centre. The professor then seemed to be wearing at his waist an enormous white skirt,* of the most advanced ballet artiste type, fitting admirably, while the peculiar-shaped tail suggested an exaggerated 'dress improver' There was a fairly strong breeze on, and the onlookers expected an instant manifestation. This, however, did not come. The professor seemed for a minute or two at a loss; but at last, realizing that something was expected, he made a short run with the machine, but it did not soar, or do anything save stick close to its occupant. The experiment was repeated with like result. Needless to say there was much disappointment, especially among the uninvited guests outside the college wall, who were prepared to cheer loudly if the professor rose in the air.

"After a little delay a long table, 3 ft. high, was got by two college porters, and with the aid of the bystanders Professor Fitzgerald mounted and made ready for another try. This was effected by his running along the table to the end, and jumping off, machine-clad as before, when he seemed to 'land' below, on his legs, with about the same force as if unencumbered.

"Undeterred by these failures another essay was made. This time cords were attached to the framework, and several parties pulled it forward, till the professor, keeping pace, had to run; and, sure enough, after 20 or 30 yds. had been traversed, the machine 'lifted' about 2 ft. from the ground, and, sustained by a rather brisk wind, carried itself and the experimentalist at that very moderate altitude for a short—in truth, a very short—distance.

"However, the outside spectators, who wanted something of a show for their expenditure of time and patience, were satisfied and applauded vigorously. A repetition of the proc-

* Like the Saracen who experimented at Constantinople in 1178.

ess produced a similar effect, and when Professor Fitzgerald disencumbered himself of the machine, it was felt all round that it had a certain potency of 'soaring' when the conditions were more favorable for the display."

A further experiment was made on April 5, by which time a sloping platform about 2 ft. wide had been erected, leading from the ground to the parapet of a pavilion. Professor Fitzgerald, clothed in the machine, backed up the platform for a short distance, and then ran down to the ground, but did not gain sufficient speed to soar, although the wind was favorable. Again and again the experiment was repeated, each time with a longer run, but without success, as the platform was evidently too narrow to admit of rapid and unobstructed movement. Two enthusiastic students had each a try, but little if any work was obtained. Finally, a small disaster brought the day's proceedings to a close. While one of the students was placing himself in position on the sloping plank and fixing the machine at a certain angle, a gust of wind tipped it up, and the whole business, man and machine, fell over inside the pavilion rails, scattering a group of onlookers, who were quite unprepared for the incident, and slightly damaging the machine.

This doubtless was soon repaired and the experiments renewed, although accounts of the same have not yet come to hand. It is very evident that, as Herr Lilienthal has all along insisted, it requires a good deal of skill and practice to learn to manage one of these machines in so yielding and fluctuating a medium as wind.

RECENT AERONAUTICAL PUBLICATIONS.

A Manual for the Practical Use of Aviators and Aeronauts. (German.) Published by W. H. Kühl, Berlin, 1895. 198 pp.

Nothing marks better the recent rapid advance in aeronautics, and the growing faith that practical success is not afar off, than the present publication, in German, of a pocket book for practitioners and students of this inchoate art. This book has been edited by Captain H. W. L. Moedebeck, of the German Artillery, assisted by Captain H. Hoernes, Dr. V. Kremser, Engineer O. Lilienthal, Dr. A. Miettre, and Professor K. Müllenhoff—all of them experts in various specialties.

The book seems to have been prepared with great care. It contains numerous tables, blank forms, and formulas, and 17 illustrations. The following is a brief analysis of its contents:

Chapter I., by Dr. Kremser, *Physics of the Atmosphere.* A very good *résumé* of aerostatics, of effects of temperatures, moisture, clouds, winds, barometric gradients. The general circulation of the atmosphere. Annual and bi-annual changes in air pressures, temperatures, and moisture. Also the electrical and optical phenomena of the atmosphere.

Chapter II., by Captain Moedebeck, *Balloon Construction.* The shape and lifting power, with either hydrogen or illuminating gas. The materials, their strength and weight. The cutting, sewing, varnishing of ordinary balloons. Pasting together of balloons made of gold-beater's skin, both by the English and the French methods. Concerning valves, netting, cars, anchors. Also captive balloons and aeroplane balloons. Warm-air balloons, with formulæ for each.

Chapter III., by Professor Müllenhoff, *Chemistry of Aeronautical Gases.* The general laws, the production and cost of hydrogen, of illuminating gas, and ammoniacal gas. It is mentioned that the latter will not answer aeronautical purposes, although it is cheap and light, in consequence of its action on the varnish, but no notice is taken of recent improvements in the production of water gas, whereby hydrogen is very cheaply produced by a process which almost entirely eliminates carbon oxide.

Chapter IV., by Captain Moedebeck, *Balloon Trips.* Air displacement and levity. Factors which limit the height attained. Extended, high, distant, or quick journeys. Trips with a predetermined terminal point, and trips with the drag-rope. Landings and precautions to take. Ballast to be used.

Chapter V., by Dr. Miethe, *Balloon Photography.* The choice of apparatus and processes to be employed.

Chapter VI., by Dr. Kremser, *Observations in Balloons.* Meteorological and other scientific principles. The instruments and their use: clocks, aneroids, mercurial barometers, psychometers, compass, maps, dry and wet bulb thermometers, together with tabular blanks, with a note on the construction of diagrams by Captain Moedebeck.

Chapter VII., by Dr. Müllenhoff, *Bird Flight.* After glancing at the literature on the subject, in the whole of which, it is said, there are no really reliable data before those published by Professor Marey, the laws and modes of flight are laid down, as observed in rowing, gliding, hovering, sailing, and circling flight, which last is said to be very difficult to explain. Then a classification is given of flying creatures, based on peculiarities of wings, and also the strength of muscles and probable work done in flight.

Chapter VIII., by O. Lilienthal, *Artificial Flight.* We would give this chapter in full, had not the editor reserved the right of translation, reprinting even with a statement of the source not being permitted.

Herr Lilienthal gives his reasons for believing that "individual flight"—*i.e.*, that of one man alone—is the proper way to begin, so as to limit the size of the apparatus and learn the tricks of the wind. Then he gives a *résumé* of the facts brought out by his experiments, concerning air reactions on wings provided with a slightly arched profile, with diagrams of the resolution of forces and a table of "normal and tangential" pressures at various angles of incidence. These diagrams and table present the peculiarity that the pressure is said not to be normal to the surface, against the belief of all physicists hitherto, that Herr Lilienthal shows these forces as applied at the centre of figure, instead of at the centre of pressure, and that he deduces the force from what he calls the normal and the tangential pressures, instead of first ascertaining the total pressure and then resolving it into the "lift" and "drift" consequent upon the angle of incidence, as has hitherto been done for planes.

The most remarkable results, however, appear from the table, which shows, for arched surfaces, that at angles of incidence exceeding 3°, the resisting component of the air pressure, the "drift" becomes negative, and acts as a propelling component, which at an angle of 15° becomes equal to one-twelfth of the lift, and does not disappear entirely until 30° is reached —a sort of "aspiration," as it were. This is Herr Lilienthal's great discovery, and holds out good hope that man may succeed in sailing the air; for he says that "A current of air rising at an upward trend of 3° (5 per cent.) above the horizontal, acts upon a horizontal arched surface with a strong uplift, without driving it back, and is the principal reason for the soaring of birds."

After giving a numerical example of the method of calculating the forces by his formula, Herr Lilienthal gives directions for practical flight, a sketch of his apparatus and experiments, and in an advertisement in the back of the book he offers to sell duplicates of his apparatus to amateurs.

Chapter IX. is in two sections: 1. *Dynamic Air-Ships*, by Captain Hermes. This consists of general considerations, formulæ, methods for determining laws of air resistance, friction, etc., dividing the various kinds of dynamic air-ships into five classes: 1. Wave line; 2. Aeroplanes; 3. Sail wheel machines; 4. Screws; and 5. Beating wings. Calculations of strength and power required. Influence of the wind, gusts, etc. The second section is 2. *Navigable Balloons*, by Captain Moedebeck, giving the results of various experiments and various failures. The proper construction of such balloons, position of the screw, choice of motors; steam, electricity, gas-engines, and petroleum-engines.

Chapter X., by Captain Moedebeck, *Military Aeronautics.* Contains a sketch of what has been done in the way of military balloons in every country on the globe; the different uses to which they may be put, and their vulnerability. Of course the latest improvements are not described, these being preserved as State secrets, to serve in case of war; but the reader will be surprised to learn how many governments now maintain aeronautical establishments, and how general the use of balloons, captive or free, is likely to become in military operations.

In addition to these practical tables, notes, and essays, this little book, which is 6 × 4½ in. and ½ in. thick, contains tables of weights and measures, specific gravities, foreign coins, postal and telegraph rates, differences in local time, a lexicon of aeronautical terms in German, French, and English, a list of aeronautical societies, and another of dealers in aeronautical supplies, as well as an inset of 40 pages ruled in blank, in the front part, upon which to enter notes of aerial journeys. At the end of the book is the bibliographical catalogue of the publisher, W. H. Kühl, Jägerstr. 73, Berlin, who makes a specialty of aeronautical publications.

The book is exceedingly well gotten up, contains the gist of what has hitherto been published of value upon the subject, and although it addresses but a limited number of readers, it is much to be desired that an edition shall be published in English, either in Great Britain or in this country.

Aeronautics. An abridgment of aeronautical specifications filed at the British Patent Office from A.D. 1815 to A.D. 1891. By Brewer and Alexander. 8½ × 4½ in., 160 pp.; illustrated; price, $2.50.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

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(ESTABLISHED IN 1832.)

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NEW YORK, AUGUST, 1895.

EDITORIAL NOTES.

THERE are two reports of economical engine performance in this issue that go to show that improved constructions in boilers and engines have been making great advances during recent years in the economical saving of coal. M. Normand, in a paper before the Institution of Naval Architects, reports the development of a H.P. on 1.56 lbs. of coal per hour, naturally attributing such results to the effective working of the water-tube boiler, and the trial of the Schmidt motor shows that the same power was developed on the consumption of 1.7 lbs. per hour. This latter is the more interesting of the two in that the Schmidt motor is a compound engine, and the saving over other forms of compounds must be attributed to a great extent to the system of superheating that the inventor uses, one of the main features of which is that the temperature of the superheated steam is actually greater than that of the gases as they escape into the stack. This is accomplished, as our readers will recollect, by passing the gases over the superheating pipes in a direction contrary to the flow of the steam, so that the latter is touched by the hottest gases just as it leaves the superheater.

A CONTROVERSY is on between the bureaus of Ordnance and Construction and Repairs in regard to the proposed new battleships. The question involved relates to the location of the 13-in. gun turrets. The Bureau of Construction and Repairs recommends that the ships carry eight 8 in. guns, two of which are to be placed in a turret above and abaft the forward 13-in. gun, and two similarly mounted above and forward of the after 13-in. gun. The Bureau of Ordnance objects on the ground that the blast from these guns will be such as to result in great discomfort if not in actual injury to the crews in the lower turrets. To maintain their position they have made some tests at Indian Head in which a 1-in. plate was deflected about 7 in. by two shots from an 8-in. gun. This they claim proves their position. The Bureau of Construction and Repairs, on the other hand, claim that the plate was placed so much nearer the blast than it would be in the actual construction proposed that the test proves nothing. It will therefore devolve upon Secretary Herbert to decide in this disagreement of the doctors. A report of the test is given in another column.

DOWN-DRAFT FURNACES.

THE statement which is made in Mr. William H Bryan's paper, read at the Detroit meeting of the Mechanical Engineers, and which is republished in another part of this number of the AMERICAN ENGINEER, that "experience in St. Louis leads to the belief that smoke from boiler furnaces can now be abated by practical means, without hardship, no matter what the type of boiler, the character of the work required of the plant, or the kind of fuel used," is made apparently with every evidence of credibility, and after a careful investigation of the subject should attract very general attention from steam users and those who suffer from the production of smoke—and, in Western cities, the latter class embraces most of the population. For at least a hundred years the consumption of smoke has been a subject of constant study and experiment by engineers and inventors, and the devices brought out to effect that desirable result have been innumerable. Some of these would, to a greater or lesser extent, effect the consumption of smoke, but the obstacle which has stood in the way of the general adoption of any of them was the fact—which soon made itself manifest after any of them were used—that it was not profitable to consume smoke. The erroneous assumption that smoke was very wasteful of fuel was generally accepted as being true, whereas careful investigation showed that the amount of waste of fuel due to the production and escape of smoke unconsumed was very little. In St. Louis and Chicago and other Western cities the smoke nuisance has been a very serious one, and legislation of various kinds to prevent or diminish it has been enacted at different times. The result has been that the attention of inventors has been directed to the subject anew, and steam users by the compulsion of the law have been inclined to adopt any device which would reduce or prevent the production of smoke. This has naturally led to many experiments and much investigation, with the result that a number of different forms of down-draft furnaces, described by Mr. Bryan, have been brought out which have produced excellent results, not only in the diminution of smoke, but they show a very material economy in the production of steam and an increase and not a diminution in the efficiency of the boilers. There are certainly results which

"We long have sought but found them not."

One form of these smoke consumers, the author of the paper tells us, has been applied to 1,600 boilers, which is an indication of its success. Tests of one of them and of a common furnace, with a combustion of coal of over 40 lbs. per square foot of grate per hour in each, showed that with the smokeless furnace 6,489 lbs. of water were evaporated per pound of coal, whereas with the common grates only 5,249 lbs. was evaporated. The smoke production "on a scale of 100" was as 74.16 to 3.19. In another test the coal consumed per H.P. per hour with the smokeless furnace was 5.25 lbs., while with the ordinary furnace it was 6.43 lbs. If these results can be obtained without any or little increased expense from other sources, it removes the great obstacle in the way of smoke consumption which has been that it did not pay.

Mr. Bryan concludes his admirable paper with the very conservative observation that "the system in its best shape is not perfect. Much has been done during the last few years in im-

proving details so as to increase the efficiency, durability, and reliability of the apparatus, but there is room for further improvements. Even in its present condition, however, it is well worthy of the careful study of progressive engineers everywhere." To which a confirmatory "Amen" may be added.

THE INTERNATIONAL RAILWAY CONGRESS.

Only very meagre reports of the proceedings of the meetings in London have thus far reached this country. At the opening the delegates were addressed by the Prince of Wales, and one of them, who has since returned, is reported in the daily papers to have said that the sentiments of the prince were entirely satisfactory to the Americans who heard them. Later, the delegates were received by the Queen at Windsor Castle, assisted by the prince, and they were entertained at a garden party.

Of the congress itself, *The Engineer* says: "It is not quite easy to regard it as existing for mental improvement. Its proceedings are more those of a great pleasure party than those to be expected from a scientific deliberative body. . . . On Monday (July 1) serious work began in the way of discussion, but it is open to question whether these discussions have added much to the store of general available information. . . . The polyglot nature of the assembly renders the proceedings rather unwieldy. In each section there is a president and two interpreters who sit at opposite ends of the presidential table. The one translates the speeches made in French for the benefit of the English-speaking portion of the audience; the other translates the English speeches into French for the benefit of the foreigners in the audience. As the interpreters are gentlemen of considerable standing, thoroughly versed in the questions discussed, the result is sufficiently satisfactory; but progress is very slow, seeing that everything said has to be said twice over. The arrangement under which the time of the meeting is wholly devoted to discussion, not the smallest portion of a paper or report being read, is quite admirable, and causes no inconvenience whatever. It is hoped that the success of the method will promote its adoption among our own technical societies."

The Engineer also calls attention to one of the rules of the congress "that the author of a paper should come to some definite conclusions at the close of his paper, these conclusions being submitted to the meeting of the section in which the paper is discussed, and amendments are then proposed by other delegates if they so wish." A large proportion of the papers, our contemporary also says, "possess only a secondary interest for its readers, dealing as they do with questions of traffic, management, and such-like, involving little or nothing of engineering." It then gives a brief abstract of the discussions which took place in Room 11, in which the papers on locomotives and other rolling stock were discussed.

The proceedings appear to resemble very closely those of our own Master Mechanics' Association, and very much the same diversity of opinion and inconclusiveness were developed. The kind of conclusions which were reached seemed hardly commensurate with the time, money and labor expended to bring together a "congress" from the four quarters of the globe. Thus it is said that "it was pointed out that if the steel plates were of good quality and not high in carbon, they could be flanged more satisfactorily than iron." Again: "One engineer stated that for smoke-box tube plates he had found that steel rusted more quickly than iron; and after considerable experience he had gone back to the use of iron for this purpose." In the discussion of spark-arresters it was pointed out that "it is absolutely essential for good work that the axis of the blast pipe be exactly in the axis of the chimney, and many an engine has been much improved in working by correcting a slight error in the position of the pipe." Mr. Clerault, of the Western Railway of France, said he preferred a bogie in front of express engines, which could twist and also swing laterally." M. Baudry, of the Paris, Lyons & Mediterranean Railway, said that formerly his company used no bogies, but they were now taking out the leading axles of many engines and substituting bogies. On the Belfast & Northern Counties Road the saving by compound locomotives was about 16 per cent. In the discussion on wheels it was brought out that Mansell wooden wheels failed on the Pennsylvania Railroad, but that 40,000 pairs were in use on the London & Northwestern.

With reference to the accommodation of passengers, "the essential point brought out was that *comfort for all, and not luxury for a few, should be sought for*"—a sentiment which ought to be inscribed in imperishable letters on every railroad station in this land of freedom and equality.

It must be admitted that the papers and the discussions, or, at any rate, that portion of them which have thus far reached this country, are disappointing, and seem to be rather commonplace. So far as their character has been indicated to us who could not attend the meetings there seems to have been but little originality in the reports or discussions that have reached us here, and not much of that kind of ability which manifests itself by collecting material from a great many sources and by a process of mental digestion, shows the conclusions which should be drawn from the facts and the evidence collected. It recalls the close of one of the Master Mechanics' conventions here, after there had been a great deal of talk and much diversity of opinion manifested and but little decisive action. Just as the terminal resolutions of thanks, etc., with which these meetings always end, a member remarked *sotto voce* to those next to him, "I now move that we adjourn, and that we all go home and do as we please." Apparently that will be the consecution of the meeting of the International Railway Congress.

THE ELECTRIC LOCOMOTIVE ON THE BALTIMORE & OHIO RAILROAD.

The most interesting engineering event of the month of July was the trial of the electric locomotive, built by the General Electric Company in their Schenectady shops, for operating in the great tunnel which the Baltimore & Ohio Railroad Company has constructed under the city of Baltimore. Heretofore this road has had no continuous line through this city excepting one through its streets, which it was permitted to operate only with horses, and that has not been used for some years past. The company was, therefore, compelled to transfer all its through cars which ran between Washington and the West and Philadelphia and New York by a ferry from Camden, at the eastern end of Baltimore, across the northwest branch of the Patapsco River, which forms the harbor of that city to Locust Point, located on its southern side. This, of course, was a serious obstacle to traffic, and as the Pennsylvania Railroad Company some years ago built a connecting line through and around Baltimore, constructed partly in tunnels and partly in open cuts, the Baltimore & Ohio Line was at a serious disadvantage in competing for traffic. To remove this obstacle, in 1890 the company commenced the construction of a connecting road extending from the old Camden Station to Bay View Junction, a distance of 7.2 miles. The actual construction was carried out by the Maryland Construction Company, and the line is owned by the "Belt Line Company," which is doubtless controlled by the Baltimore & Ohio Railroad Company.

The line enters the mouth of the tunnel alongside of Camden Station, under Howard Street, on which formerly a large part of the flour business of Baltimore was done when the only means of transportation were the Canastoga wagons, which brought the produce from Pennsylvania, Maryland, Virginia and Ohio to Baltimore, over the turnpike roads which centred there. It was on this street that the place of business of Rob-

ert Garrett & Sons was originally located, the senior member of which firm was the father of John Garrett, the noted former President of the Baltimore & Ohio Road and the grandfather of Robert Garrett, Jr., who succeeded his father, John, in that office. It was here in the flour business that the foundations were laid of the fortunes which the son and the grandson have since inherited. The tunnel extends under Howard Street from Camden Station and emerges at the northern side of the city and is 7,339 ft. long. The soil under Howard Street consists chiefly of sand, through which run seams of gravel and a hard species of clay, and presented great difficulties in the prosecution of the work.

The operation of such a tunnel with the amount of traffic which it would be necessary to carry through it of course brought up the question of ventilation. Various schemes were suggested, but were abandoned, and the offer of the General Electric Company to construct electric locomotives of a capacity to haul the heaviest trains was finally accepted. The first one of these engines has been delivered, and its trial during the month of July, as we have said, has been the event of the month.

The electrical equipment, as first outlined, was described by the electrical company as follows :

"The locomotives were to operate from Henrietta Street about 1,800 ft. in the open to the portal of the tunnel at Camden Street, and thence to the further end at Mount Royal Avenue, and for 4,600 ft. further on in the open, or a total distance of about 14,500 ft. The locomotives were to join the rear end of passenger trains going north, at Henrietta Street, and push both cars and locomotives through to the second station, from which point the steam locomotive was to do all the hauling. Freight trains were to be pushed the entire distance. The calculations were to be based on a maximum weight of 500 tons for each passenger train, including the steam locomotive, with a speed of 35 miles an hour, and on a maximum weight of freight trains of 1,200 tons at a speed of about 15 miles an hour on a grade of 0.8 per cent. The number of trains each way was to be about 100 a day. An electric lighting plant with large incandescent lamps for the tunnel and arc lights for the stations was also contemplated."

The plan of pushing the passenger trains through the tunnels has been abandoned, in view of the possible results if one of the cars or the steam locomotive should leave the track in front of the heavy electric locomotive travelling at 30 miles an hour.

The power house is located on the west side of Howard Street, east of the tracks leading to the southern portal of the tunnel and south of Camden Station. There are 12 water-tube boilers of 250 H.P. each, built by the Abenroth & Root Company, of New York. The dynamos are driven by four cross compound engines built by the Edward P. Allis Company, of Milwaukee. There are also four high-speed Armington & Simms engines for driving the electric-light plant.

The engines have two trucks each with four driving-wheels 62 in. in diameter and two motors to each truck. The wheelbase of each truck is 6 ft. 10 in., and the total weight on driving-wheels is 192,000 lbs.

A number of tests of the engine have been made, and, as might be expected at first, some failures have been reported. It seems, however, established that it can pull heavy trains, but as yet no intimation is given of the consumption of fuel in doing it, which is, of course, the important economical question. That it will be very great may, however, be expected, as a single engine working at intervals would not be working under the most economical conditions. Even if all the work in this tunnel should be done with electric locomotives, probably not as economical results would be obtained as may be expected if a line was operated with a large traffic and many engines. Before the death warrant of the steam locomotive is read a certificate should be appended to it giving the fuel consumption of its successor. The veracity of electricians and the voracity of their engines is now on trial.

BOOKS RECEIVED.

An Experimental Study of Field Methods which will Insure to Stadia Measurements Greatly Increased Accuracy. By Leonard Sewal Smith. Bulletin of the University of Wisconsin, Madison, Wis.

Proceedings of a National Convention of Railroad Commissioners. Held at the Office of the Interstate Commerce Commission, Washington, D. C., May 14 and 15, 1895. Washington : Government Printing Office, 1895. 80 pp., $5\frac{3}{4} \times 9$ in.

Transactions of the American Institute of Electrical Engineers. Vol. XI. Meetings of January 7, February 21, March 21, April 18, May 15, 16, 17 and 18, September 19, October 17, November 21, and December 19, 1894. Published by the Institute, New York. 938 pp., $5\frac{3}{4} \times 8\frac{3}{4}$ in.

Report on the Use of Metal Railroad Ties and on Preservative Processes and Metal Tie plates for Wooden Ties. By E. E. Russell Tratman. [Supplementary to Report on the Substitution of Metal for Wood in Railroad Ties, 1890.] Prepared under the Direction of B. E. Fernow, Chief of Division of Forestry. Published by authority of the Secretary of Agriculture. Washington : Government Printing Office, 1894.

NEW PUBLICATIONS.

The Design, Construction and Maintenance of a Marine Boiler. "Shipping World Series." London : *Shipping World* Office. 29 pp., $5\frac{1}{2} \times 8\frac{1}{2}$ in. Price, threepence.

In a note appended to the title it is said that "this series of papers, now published in pamphlet form, was originally written for the assistance of captains and officers intending to take the voluntary examination in steam." If this is the main purpose of the pamphlet, we cannot but feel sorry for the "captains and the officers." The articles consist of a rather miscellaneous assortment of information relating to marine boilers—not in itself bad or useless, but totally inadequate to give persons who are supposed to be entirely ignorant of the subject the information which they would require and which ought to be given in a "series of articles" which purport to be what these are not.

Position Diagram of Cylinder with (Meyer) Cut-off at $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$ and $\frac{1}{8}$ Stroke of Piston. New York : Spon & Chamberlain. 25 cents.

This is a sectional view of a steam cylinder printed on a card, and with sectional views of the main and cut-off valve used in the Meyer gear and movably attached to the card so that they can slide in relation to the valve face and to each other. A circumferential diagram showing the movement of the crank with arcs drawn with the length of the connecting-rod as a radius for making the connection due to the angularity of the rod, and similar diagrams to indicate the movement of the two valves, are drawn on the centre line of the cylinder and valves. There ought to be some explanatory text go with it. An elementary and clear explanation of the Meyer gear and what the diagram is intended to show would add very much to the usefulness of this publication.

Construction of Stationary and Marine Steam-Engines. (Printed in French.) By Maurice Demoulin. Paris : Baudry & Co., 430 pp., 7×11 in.

This book, were it published in English, would be called a practical treatise on the steam engine. It is intended to supply that information regarding the construction of steam-engines that is usually acquired by practical men in the course of their work, without order and without arrangement, and which is not ordinarily taught in the schools ; and, while it has, of course, been impossible to so elucidate the subject under consideration that the reader will have that intimate touch with the subject that is evidently possessed by the writer, all of the information given is of that practical sort so indispensable to any one engaging in active engine construction. The book is not by any means a didactic treatise on the steam-engine. It is written in a perfectly practical way, and avoids those topics that are usually made the subjects of examination, and on which there are already such a multiplicity of books. It takes it for granted that the reader is already familiar with the operation and theory of the steam-engine, and is to a great extent limited to the information required for the construction of an engine, the considerations that should influence the choice of the type to be used and the

determination of the principal dimensions, as well as the proportioning of the principal details.

The theoretical and practical knowledge of the steam-engine is condensed into a single chapter, which is the first in the book. The second chapter treats of the circumstances that should influence the engineer in the choice of the type of the engine to be used. The third chapter is devoted to the determination of the main details of the engine, and to the calculation of the dimensions of the cylinder; and this same system is followed with the frame, the pistons and piston-rods, crossheads, cranks, shafts, bearings, fly-wheels, valves, condensers, and air-pumps, and the fittings of the machine.

The value of the book lies in the fact that it is not limited to French practice, but has gone abroad for the best examples of steam-engine work that could be found, turning to the United States especially for stationary engines and to England for marine engines. The book is very fully and completely illustrated by process engravings, upon which there are no dimensions, but which serve to show very clearly the form of the parts represented. The book is well printed, and our only regret is that the language in which it is published is not one that is understood by the majority of our readers.

TRADE CATALOGUES.

In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. The advantages of conforming to these sizes have been recognized, not only by railroad men, but outside of railroad circles, and many engineers make a practice of immediately consigning to the waste-basket all catalogues that do not come within a very narrow margin of these standard sizes They are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.

STANDARDS.

For postal-card circulars.............	$3\frac{1}{2}$ in. × $6\frac{1}{4}$ in.
Pamphlets and trade catalogues......	$3\frac{1}{2}$ in. × 6 in.
	6 in. × 9 in.
	9 in. × 12 in.
Specifications and letter-paper........	$8\frac{1}{2}$ in. × $10\frac{3}{4}$ in.

The Pilot File System. Keuffel & Esser Company, New York. 28 pp., $5\frac{3}{4}$ × 9 in. [Not standard size.]

The articles illustrated and described in this pamphlet are letter files and not the abrasive tools used by mechanics. Various forms of files and other appliances for storing and classifying papers of various kinds are explained, and also shelving and cases for storing the files.

Light. 8 pp., $5\frac{3}{4}$ × 9 in. The Safety Car Heating and Lighting Company of New York have reprinted in an attractive form an article which first appeared in *Trade and Travel*, published by the Commercial Travellers' Club, of New York. It is illustrated with views of the interiors of Pullman and other cars which are intended to show the convenience and comfort which results from the lighting of cars by the Pintsch system. The words of the apostle Peter might be quoted to the commercial traveller: "Ye should shew forth the praises of him who hath called you out of darkness into his marvellous light."

Protection of Grade Crossings of Steam Railroads with Electric Railways and Protection of Facing Point Switches. By Charles Hansel, C.E. The National Switch & Signal Company, Easton, Pa. 26 pp., $7\frac{1}{4}$ × $10\frac{1}{4}$ in. [Not standard size.]

This company has here reprinted several articles by Mr. Hansel, their manager—the one on Protection of Grade Crossings of Steam Railroads with Electric Railways, and the other on the Protection of Facing Point Switches. These are followed by the Travis Derailing Switch.

All of the articles are illustrated, and show the methods and appliances employed by the National Company for protecting crossings, etc., and gives a full statement of the reasons for what they recommend. The descriptive matter is all very clear, and there is a refreshing absence of display type and boastful statements which have the savor of the commercial traveller about them. It is printed in excellent taste, and might be designated as a gentlemanly trade catalogue. Its modest appearance and temperate statements incline one to believe all that it contains, whereas the strident character of some examples of such literature incline one to doubt all the statements they contain.

The Peerless Rubber Manufacturing Company, Manufacturers of Superior Mechanical Rubber Goods. New York. 72 pp., $5\frac{1}{2}$ × 8 in. [Not standard size.]

The uses to which india rubber is now put are many. The tract before us is intended to state the merits and the kinds of goods which this company makes. These include packing of various kinds, gaskets, rings, pump valves, hose for a great variety of purposes, and a rubber cement for air-brake, steam and other hose couplings, rubber and leather belting, matting of various kinds, etc. The only fault to be found with this catalogue is that it is printed in blue ink, the object of which is not apparent.

Illustrated Catalogue of Mining, Milling and Smelting Machinery. Reynolds' Corliss Engines. Manufactured by the Edward P. Allis Company, Reliance Works, Milwaukee, Wis. 120 pp., 6 × 9 in. [Standard size.]

The machinery described here is somewhat out of the range of the American Engineer, and therefore it will receive a mere mention. It includes such things as crushers, rolls, stamps, mortars, concentrators, amalgamating pans, agitators, screens, jigs, furnaces, blowing and winding engines, etc. These are all illustrated with excellent wood engravings and good descriptions.

Willans' Central Valve Engine. M. C. Bullock Manufacturing Company, Sole American Manufacturers. 36 pp., $7\frac{3}{4}$ × $10\frac{1}{2}$ in. [Not standard size.]

The purpose of this publication is to set forth the design, construction, merits and advantages of the Willans engines, which has been extensively adopted in England, but is not so generally known here. With this object in view, the publishers give a perspective view of an engine of this kind which is used for driving their works in Chicago. The opening part of the text is a statement of the chief points of excellence of this engine. This is followed by a chapter called a "Retrospect," in which the processes and reasons are described by which the Bullock Company was led to abandon the Corliss type of engine for electric light and power uses for the Willans plan. The data of tests of such engines made by Professors Kennedy and Unwin are given on page 13, which show a consumption of feed water per I.H.P per hour of 19.11, 18.7 and 12.74 lbs. respectively. A diagram is also appended which is a plan of engine-room showing the relative space occupied by a 380-H.P. Corliss engine, belted directly to two generators, and that required for a 365-H.P. central valve engine, coupled direct to a generator. The space occupied is 1,724 and 216 sq. ft. respectively. A view follows this, showing the interior of the St. Pancras vestry, Regents' Park Station, in London, with a description and plan. After this the reader is given a description of the engine occupying five pages and a sectional view which fills another We are not able to speak in very high commendation of either of these. The description is not a model of lucidity and the engraving is execrably bad. Lists of engines in use, reports of tests, and "queries answered," with a number of half-tone engravings of engines—a number of them from photographs taken at the World's Fair in Chicago—complete the volume. The engravings are printed in blue ink, which it is thought detracts somewhat from the distinctness of the prints. The great defect of half-tone engravings is want of definiteness. The paler the ink with which they are printed, the more indistinct they become, and the converse is also true that the blacker the ink the better for this kind of work. The paper and press work are excellent, although with different ink the illustrations, it is thought, would have appeared to better advantage, excepting the sectional view, which no ink nor anything else could improve. Our criticisms are of the catalogue and not of the engine. In another pamphlet the makers publish a very long list of those which have been installed in England, and a shorter one of those used in this country, which form, perhaps, the strongest testimonial which could be given of the success of this type of motor.

Catalogue and Price-List of Theo. Alteneder & Sons, Manufacturers of Drawing Instruments, Philadelphia. 111 pp., 6 × 9 in. [Standard size.]

On the title-page of this catalogue it is announced that the firm was "established" in 1850, and consequently it is now in its forty-fifth year. The opening chapter, therefore, is very

appropriately a history of the development of the instruments made by the firm. The peculiarities—especially of the "Alteneder patent point"—are fully described and illustrated, and other peculiarities of construction are also explained. The observations about drawing pens will be especially interesting to draftsmen, as there is no one instrument that is the cause of so much "botheration" as the ordinary pen which every draftsman must use. The evolution of the "spring hinge ruling pen," which the Messrs. Alteneder make, and which permits the blades to be separated and cleaned without moving the adjusting screw, is fully described, and the present perfected instrument is illustrated. The evil effects of corrosive ink is also pointed out, and the lesson is enforced by engravings which represent the magnificent views of the blades of pens which were sent to this firm to be repaired, and represent in material form, what probably assumed the character of a moral, or, rather, immoral, incitement to profanity in the persons who had used the pens.

Referring to the materials of which instruments are made, this firm do not speak approvingly of aluminium, but advise against its use. This metal, they say, "when pure is very soft—somewhat like tin. Its surface is so easily abraded that it soils the hands, and, while it does not tarnish as readily as German silver, the perspiration of the hands will rapidly corrode it." When hardened with a sufficient quantity of copper, silver, or other metal, the aluminium forms less than 15 per cent. of the composition, so that there is but little advantage gained in lightness. They recommend this metal, however, for triangles and the handles of ruling pens.

All the different classes of instruments made by this firm are illustrated and described, and they embrace a large assortment. Among these is a leather pocket case for packing and carrying instruments. This has an ordinary wooden block with indentations to receive the instruments, with an outside covering of morocco. The need of some such device most draftsmen probably have often felt when called upon to pack up their "tools" in a hurry and carry them in a trunk or "grip-sack" or in their pockets.

The only instrument represented in the book which we feel like criticising is their beam compass. They still adhere to the traditional type of that instrument, which is simply infuriating, because every time the screw is slackened which holds the sliding head to the beam the head becomes detached and must be held in position. In the Railroad and Engineering Journal for March, 1890, a form of beam compass was illustrated, which the writer has used for 40 years with very great satisfaction. If some maker should bring out an instrument of this kind, they would be conferring a great benefit on the draftsmen's fraternity. The other feature about Messrs. Alteneder's very excellent catalogue which we are inclined to criticise is the binding. The sheets are fastened together by wire, so that the book does not open comfortably, but it is almost necessary to pry the pages apart. A good many binders seem to think that the purpose of binding is to keep books *closed*, whereas every reader will agree with us that what should be aimed at is to have books open readily and comfortably.

LOCOMOTIVE FOR THE MEXICAN RAILWAY.

To the Editor of The American Engineer and Railroad Journal :

It seems to me that you have overlooked one very important defect in your remarks on the locomotive for the Mexican Railway in the May number of The American Engineer.

You speak of the advantages of the plate frames and underhung springs, but you don't state that the particular underhung springs referred to are apparently *without equalizers!* As you know, the engines in use here on all the railways are most of them of English make, and the roads are owned in England and Europe and operated by English or European officials, still they find it necessary to put a Bissel truck under their six-coupled freight engines, so that they are practically moguls. Again, the results obtained with American equalized engines have been so much more satisfactory than with the unequalized English (old type), that both managers and motive-power superintendents insist on having new English engines equalized.

During my five years' stay here I have been very much pleased with the working of the locomotives used by all the roads running out of Buenos Ayres for their local traffic. I refer to a class of engines much resembling that illustrated in your journal on page 153 of Vol. LXVII (March, 1893). These engines are of the ordinary eight-wheeled type with the frame extended behind, carrying a very short tank but one having considerable water-carrying capacity combined with the side tanks above the running boards, which are not carried up very high and do not saddle the boiler. Under the extended frame carrying the tank is a single pair of wheels, generally considerably larger than the leading truck wheels.

Engines of this class are almost never turned, and may be seen to enter the central stations here in Buenos Ayres with heavy local trains of seven, eight, or 10 American cars, running both backward and forward, and generally uncoupling from one end of the train simply for the purpose of coupling on to the other end, and leaving again in a few minutes on another run of 10, 15 or 20 miles or more.

I have often thought that were I ever to occupy a position on a railway at home again that had a heavy suburban traffic, I should do my best to have some locomotives of the same general class tried.

It may interest your readers to know that the heavy through night trains here are made up of American sleeping cars almost entirely, and drawn by the English moguls before mentioned. During the summer months I have seen, night after night, two trains of from 10 to 15 eight-wheeled cars go out on the Southern Railway, each drawn by a large freight mogul with the Bissel truck *not* equalized with the front drivers; and the night trains for and from Rosario, on the Rosario Railway, made up of from nine to 12 eight-wheeled cars (from four to seven being sleepers) daily pass our factories, drawn by the same style of English moguls that are used on the same road for freight traffic.

Yours very truly,

Buenos Ayres, June 7, 1895. W. V. B.

TRUTHS TO KNOW WHEN BUYING BOILERS.

[In response to "Facts," a pamphlet issued by the Babcock & Wilcox Company, and partly reprinted in these pages, the Hogan Boiler Company has issued a counterblast with the above title; and as we believe in free discussion, the following is a reprint of it, excepting that the name of a certain company has been omitted when it occurs several times and the references to it have been made impersonal.—Editor American Engineer.]

The provision for the combustion of the fuel and the distribution of the heated gases in relation to the heat absorbing surfaces of steam boilers has received little if any attention. No change has been made since the first forms of the Scotch marine boiler, of one of the types of the "*straight*" water-tube boiler, and the horizontal tubular boilers were built. In these boilers the space beneath the heating surfaces above the grate varies in height from 14 in. to 28 in.

A COMPARISON.

The proportional areas of the flue tube openings in marine boilers and between the water tubes in water-tube boilers of one type varies from 22 sq. in. to 35 sq. in. per square foot of grate area.

In the Hogan stationary and marine water-tube boilers the space beneath the heating surfaces above the grate is from 18 in. to 42 in. in height, and the flue area around the water tubes is from 90 sq. in. to 50 sq. in. to each square foot of grate, the areas reducing as the distance from the grate increases.

THE EFFECT.

The results of this marked difference in design in the Hogan water-tube boiler as compared to other boilers may be summarized :

1. In the Hogan boiler, a large volume of gases at relatively high temperatures is maintained around all the tubes and heating surfaces.

2. In the Hogan boiler, with a forced draft of 1 in. or 2 in. of water pressure, a square foot of heating surface will evaporate twice the quantity of water that a square foot of heating surface will evaporate with a forced draft of 6 in. to 8 in. of water pressure in a Scotch marine boiler or one type of water-tube boiler.

REPAIRS NEEDED.

In the Scotch marine boilers, the intense temperatures due to high pressure forced drafts produce leaks around the tube-plates against which the heated gases are impinged, combustion chambers and their stays are irregularly strained and repairs are soon needed.

In the "*straight*" water-tube boiler of the type referred to, the expanded joints in the headers are strained, the tubes sag, bend down and split, on account of the excessive expansion of the "*straight*" tubes when exposed to high temperatures.

NO DISTORTION.

In the Hogan water tube boiler the formation of the tubes is such that the most intense heat will not strain the expanded

joints or distort the form of the tubes—the location of the expanded joints prevents any impingement of the heat on the tube-plates. In this boiler there are no obstacles such as headers, stayed tube-plates, etc., to the free expansion of all tubes.

HARD SCALE.

In the "*straight*" water-tube boiler of the type referred to, as well as in the Scotch marine—and it may be said in all other boilers except the Hogan water-tube boiler—the feed water with its foreign matter and impurities is delivered into those boilers in such a manner that when precipitation takes place the sediment falls on the surfaces exposed to the heat of the fire and the heated gases and is baked into hard scale.

SCRAPERS.

In a pamphlet recently issued by the Babcock & Wilcox Company, of New York, this condition is admitted to exist in the water-tube boiler of that company's manufacture. It is claimed that a "*straight*" tube is a necessity, notwithstanding its dangerous resistance to expansion and its ultimate distortion into a bent form. This "*straight*" form of tube when the space in front of the boiler is as long as the tube, permits the use of a long scraping bar with which the scale, which forms on the surfaces of the "*straight*" tubes and sometimes fills them up solid, can be knocked and pushed out of the tubes through the header at the back end.

"SELF CLEANSING."

It is also reasonably claimed that no water tube in a steam boiler, be it "*straight*" or bent, can be "self-cleansing." This claim by some boiler-makers for the existence of "self-cleansing" water tubes in steam boilers is probably based on the high and impracticable velocities which the late Mr. Babcock endeavored to prove to exist by the use of myriads of figures.

PRECIPITATION.

Whenever the precipitation of the foreign matter in water takes place and the sediment is permitted to come in contact with surfaces exposed to the heat of the fire, heated gases or steam, hard scale will form, and will have to be removed in a manner similar to that used in boilers of the Babcock & Wilcox type, or it will have to be chipped.

WATER PURIFIED.

If the foreign substances and sediments held in suspension in water are not allowed to precipitate or come in contact with the surfaces in steam boilers which are exposed to the heat of the fire and the gases, no scale will form on these surfaces.

In other words, if the water is purified by precipitation taking place before the water comes in contact with the surfaces exposed to the heat, no hard scale will come into existence on these surfaces, and no cleansing with a scraper will be or is necessary.

BELOW THE WATER LEVEL.

In the Hogan stationary and marine water-tube boilers the feed water enters the inductors and passes thence to the circulating tubes, where precipitation takes place below the water level and at a temperature within five degrees of that of the steam. The circulating tubes are not exposed to the heat of the gases. The results of the precipitation deposit in the external part of the distributing drum, which is not heated, and pass to the mud drum, which is an external vessel and not exposed to any heat.

PRACTICAL.

The heating tubes in the Hogan water-tube boilers are therefore not "self-cleansing," and do not require the use of a scraper or pick as in the "straight" water-tube boiler. This has been demonstrated in practice. A Hogan water-tube boiler and a "*straight*" water-tube boiler are located in the same city. Each boiler uses the city water. Every month the straight tube boiler is cleaned, scraped and picked. Scale from ⅛ in. to ⅜ in. in thickness is regularly removed. The Hogan boiler has now entered its second year. Three examinations have been made and no scale has been found. A soft deposit has been found in the distributing and mud drums, but no hard scale has been brought into existence.

BURSTING.

If the "*straight*" water-tube boilers referred to are not cleaned in two months, even when using rain water, dangerous and fatal results have been the consequence. Horizontally inclined "*straight*" water-tube boilers of this type may be described as packages of tubes crowded together, which soon bend and sag into irregular forms, accumulate and fill with scale previous to burning and bursting. Such surfaces cannot be considered better than packages of bent tubes which do not change their form, accumulate and fill with scale before burning and bursting. Such are the boilers which have been offered to steam users, until the introduction of the Hogan water-tube boilers.

PICK AND HAMMER.

A boiler of the horizontally inclined "straight" water-tube type or of any form in which it is admitted by the manufacturers that scale accumulates on the heating surfaces and becomes hard and has to be removed by scraper, pick and hammer is dangerous, is uneconomical in its operation, and its durability is purely accidental.

WATER SURFACE.

The extent of the surface of the water from which the steam as it is produced has to escape in the marine boiler as in the water-tube boiler of this type and in other boilers is the same under all conditions of firing. Thus, if the water surface is 60 sq. ft. in area, and apparently sufficient when burning 12 lbs. of coal per square foot of grate surface, this same area of water surface is supposed to give off double the quantity of steam when using 24 lbs. of coal per square foot of grate. The effect of this limitation of water surface is great agitation of the water, which takes place under either conditions of firing as indicated by the motion of the water in the gauge glass and by the wet condition of the steam.

DELIVERY OF STEAM.

In the Hogan boiler each tube delivers above the water surface the steam as it is produced. There is no hindrance in the form of water to the exit of the steam from each tube. The higher the temperature of the gases the more rapidly steam is produced, the greater the tendency to superheat the steam. Wet steam cannot escape from a Hogan boiler. A mechanical steam extractor relieves the steam from the water which falls back and passes down the circulating tubes.

"SECTIONAL."

A boiler composed of the least number of parts is more desirable than one composed of many. A boiler composed of one or more steam shells, "straight" 4-in. tubes, cross boxes of irregular forms, headers with innumerable covers and joints, cast mud drums with a half dozen or more connections, a dozen or more connecting nipples, buried in a mass of brick-work, covered with soot on the flue side and with scale on the water side, may be said to be a boiler of the past, no matter how many may now be in existence, and such a composition of parts for a steam boiler is fully entitled to the term "sectional."

A UNIT.

A properly designed steam boiler consists of one steam cylinder, 2-in. bent tubes, two distributing drums, one wrought iron or steel mud drum with two connections and five manhole covers, all placed above the grate level. The tubes are directly above the grate, and no soot accumulates on them on account of the intense heat, and no scale forms on the water side of these tubes because no sediment is permitted to enter these water spaces. The whole is enclosed in non-conducting material. Such a boiler is a *unit* and in no sense "*sectional.*" This is the Hogan stationary and marine water-tube boiler.

REMARKS.

The Hogan water-tube boilers are the same for land uses as for marine purposes.

In some straight water-tube boilers the 4-in. tubes were discarded and replaced by smaller tubes when this class of boiler was put on board ship.

The Scotch marine boiler, when used on land, is exactly the same as when used at sea.

What is bad on land in a steam boiler is equally as bad at sea. What is good at sea in a steam boiler is equally good on land.

"TRUTHS AND FACTS."

The publication of the pamphlet "Facts" is most opportune, as it is most desirable that steam users should be informed that the horizontally inclined "*straight*" water-tube boilers are accumulators of scale and that the scale cannot be removed or reduced only by the use of scrapers, picks and hammers.

Those about to buy steam boilers should read "Truths," "Facts," and the following articles in the *Boiler Review*—viz., No. 1, pages 28 and 43; No. 2, page 85; No. 3, pages 125 and 130; No. 4, pages 146, 187 and 194. It will be then readily seen what is the difference between the term of bluff, "Facts" and the statement of "Truths." *

* THE AMERICAN ENGINEER should be included in these sources of information.—EDITOR.

NOTES AND NEWS.

Fast Railroad Time in England.—Arrangements have been completed for running, beginning next month, a train to be known as the American Special Express. It will make the run from London to Liverpool, 201 miles, in three hours and 50 minutes, and, northbound, will make close connections with the transatlantic steamers. The train will make no stops, and its schedule time will be 45 minutes faster than that of other express trains between the two cities.

Bearings for Railway Cars.—From some experiments made on the lubrication and wear of bearings by E. Chabal, on the Paris, Lyons & Mediterranean Railway, he draws the following conclusions:

The result of the tests made showed that the wear of white-metal bearings was 50 per cent. less than in the case of bronze bearings. The tests also showed that, by the use of white-metal bearings, a diminution of 20 per cent. on the resistance of fully-loaded coal wagons, forming trains weighing 300 tons, travelling at speeds of 16 miles to 26 miles an hour, was given: that, as the speed increased, this gain was diminished, but remained always 5 per cent. less. As a consequence of these tests, the Paris-Lyons-Mediterranean Company in 1893 abandoned the use of bronze bearings for carriages and wagons, and adopted white-metal bearings.

A Test of Schmidt's Superheater.—In our issues of April, May, and July of this year we have given accounts of the Schmidt superheater and steam-engine, which has attracted some attention on account of the success that has been attained in the use of superheated steam. In a recent issue of the *Revue Technique* there is an account of a test that has been made with the device in regard to which we cull the following particulars: The engine subjected to the test had a cylinder diameter of 12¾ in. and a stroke of 19.7 in., and was run at the average speed of 116.3 revolutions per minute, developing 72.56 I.H.P. and showing 62.6 H.P. at the brake. The pressure at the boiler was 167.4 lbs. per square inch, and the temperature of the steam was 660° F. on leaving the boiler, and 605° on entering the engine. The results obtained on tests, lasting for about seven hours, showed that the consumption of water was 12½ lbs. per effective and 10.8 lbs. per I.H.P. At the same time the consumption of coal was 1.7 lbs. per effective and 1.4 lbs. per I.H.P. per hour.

Nickel Steel for Boilers.—Some time ago the Government asked bids for some of the leading steel makers on 20,466 lbs. of steel to contain not less than 3 per cent. of nickel and to meet specifications as follows: Tensile strength, 80,000 lbs.; elongation of at least 25 per cent. in 8 in.; and an elastic limit of at least 50,000 lbs. per square inch. Owing to the very rigid requirements, only two firms bid on the work, these being Carbon Steel Company and Carnegie Steel Company, Limited, both of Pittsburgh. The Carbon Steel Company were ready to guarantee an elongation of 25 per cent. in 2 in. instead of 8 in., and consequently their bid, being informal, was not considered. The work was placed with the Carnegie Steel Company, Limited, at 5¼ cents per pound, delivered, Washington, D. C. The plate is about 1¼ in. thick, and is for the armored cruiser *Chicago*, which is to have an entire new set of boilers. The firm rolled eight plates, but these were rejected on three different inspections as not coming up to specifications. On the fourth test one of the plates is said to have showed a tensile strength of 86,000 lbs. to the square inch, and to slightly exceed the severe requirements in reduction of area and elongation.

The Result of Working Eight Hours per Day.—Mr. Brunner, of the firm of Brunner, Mond & Co., sends to the London *Times* an interesting report of the result of a five years' experience of the eight-hour rule in his works. He says that at first the wage-cost per ton went up, then dropped, and is now as low as it was in 1889, the last year of the twelve-hour day. In other words, the men get as much work done in eight hours as they used to get done in twelve. That this is not merely the result of a coincidental improvement in machinery or the methods of manufacture is vouched for by the managers of the works, who have considered the point. Their opinion that, though the men work less hours, the efficiency of their work is not diminished, is supported by their report as to the improvement in greater regularity of attendance, increased application, and improved health among them. The men used often to be irregular and drunken; these offenders are now rare. "The men come down to their shifts regularly, and they come sober." In the long double shift at the end of each week, which is necessary for the work, the men used often to be found asleep. This does not occur under the new conditions. Lastly, the health of the men has much improved. "The improvement in the men's looks, and especially in their gait when leaving the works at the end of the shift, is very marked."

Records of Inventions.—In an interview with Mr. Charles F. Brush, the distinguished electrician, which was recently published in the New York *Herald*, he is reported as saying that he had "no doubt that the heads of the Patent Office are honest, but I have had a number of experiences which lead me to believe that the subordinates sometimes allow important information to leak out. I have applied for patents again and again, only to find interferences filed before they were granted, and it is only through my great care in keeping records of my work that I have been able to secure a number of my inventions. Take the arc light. While I was working upon it and attempting to make it commercially profitable, I kept a very full journal of all my experiments. I recorded everything from day to day, and dated it, and had witnesses called in to sign the records. This I found of immense value to me in my patent suits. I had 200 of them, and gained all except one."

This practice of keeping a journal of an invention is one which may be followed with advantage by all inventors, and records made in this way may be of very great value in establishing priority of discovery, which is so essential to the validity of a patent.

Superheated Steam.—In giving the results of their protracted experiments with saturated and superheated steam, the Alsace Union of Boiler Owners say that, theoretically, it has never been denied that superheated steam should give a higher efficiency than saturated, yet from apprehension of the cylinder becoming damaged by the high temperature, for years no experiments were undertaken with superheated steam. Subsequently, however, after numerous trials, the oldest engine even was found capable of being safely used with superheated steam, and not only without injury, but more economically than with saturated. It is also declared by the Union that in installing a superheater care is essential that the advantages gained are not lost either by less perfect combustion or by greater radiation losses—the cost of the superheater not to exceed, of course, the saving obtained in coal consumption; the superheater to be connected with the boiler, so that both can be fired from the same furnace; and, after leaving the superheater, the gases should come in contact with the heating surface of the boiler, and, lastly, with the heating surface of the economizer. Further, these experiments showed that the use of superheated steam does not exclude the use of steam jacket. Though both superheating and steam jackets were used, yet condensation in the high-pressure cylinder occurred. The use of low pressure, 7½ atmospheres, did not give such good results as the use of high pressure, 11½ atmospheres.

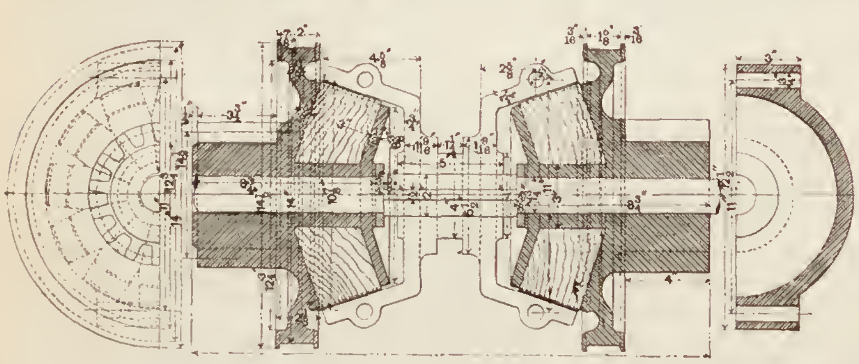
Oil-Burning Locomotive.—Another locomotive for burning oil has been tried on the Southern California Railway. It is the invention of William Booth, formerly Master Mechanic of the Peruvian Central Railway, who has been assisted by Master Mechanic Prescott, of the Southern California Line. In a somewhat brilliantly colored account of it in the Los Angeles *Express*, it is said that "the oil-tank holds a little over 5 tons of oil, and is firmly located inside the water-tank—that is, the water surrounds the oil reservoir. There is 6 ft. of water on the back end of the tank, 18 in. on the sides and front, and 6 in. on top. It is provided with an oil-tight manhole and has a gas vent, so that any amount of shaking about or even upsetting will not cause the oil to escape. Provisions for safety from fire or explosion are still further secured by two automatic safety-valves, one on the top and the other on the bottom of the tank. In case of accident breaking loose the tank from the engine, a rope on the top valve and a chain on the bottom one shut the safety valves and cut off the flow of oil instantly, keeping it confined to the inside tank. Two burners are used with two steam-jet atomizers."

It is said further that "the new equipment is safer than using coal; steam can be raised quicker and better maintained; there is no obnoxious smoke, and no destruction of private property by sparks, as sparks are neither emitted from the smoke-stack nor dropped from the fire-box"—all of which sounds like an old, old story.

Gas Engines.—Treating of gas engines as at present employed in England, Mr. Donkin has stated before the English Institution of Gas Engineers that such engines are usually made there in sizes ranging from ½ to 600 I.H.P., and there is a marked increase constantly in the sizes and numbers sold. The use of ordinary lighting gas is customary in sizes up to 10 H.P., but for larger sizes a small convenient apparatus has been devised for the production of a gas that cannot be used for illuminating purposes, but which gives very

economical results when burned in an engine cylinder. For this article, termed a generator gas, the best fuels employed in its production are found to be anthracite coal and gas coke, as they yield no tar. The thermal efficiency is low, it having about 160 heat units per cubic foot, as compared with 615 to 630 of London lighting gas, and consequently about four times the quantity is required to produce the same amount of power. The great quantity obtained, however, together with the small amount of depreciation and labor involved in production, render it in many cases comparable in cost to gas at 20 cents per 1,000 ft. The disadvantage is acknowledged that gas engines cannot be started under full load, requiring the use of friction clutches, in most instances having but one impulse to each four movements of the piston, necessitating greater weight per H.P. than with steam; on the other hand, the gas engine can be started instantly, and there is no danger from fire when it is shut down.

Friction Clutch for 5-Ton Crane.—In our last issue we published an illustrated description of a 5-ton crane built at the shops of the Baltimore & Ohio Railroad. We now supplement this with an illustration of the friction clutches used for hoisting and raising the boom. It will be seen that the construction is very simple. The pinion on the outside at the left has a pitch diameter of 6 in., with 15 teeth of $1\frac{1}{4}$ in. pitch, and is used for hoisting the boom. The mate at the other



FRICTION CLUTCH FOR 5-TON CRANE.

end has a diameter of 6.27 in., with 13 teeth of $1\frac{1}{2}$ in. pitch, and does the hoisting. Each pinion is cast solid with the brake-wheel, and the shell for carrying the hardwood friction-blocks. These friction-blocks are put in with the end of the grain presented to the wearing face of the shoes and with an original projection of $\frac{1}{8}$ in. beyond the face of the shell. In other respects the construction of the clutch with all of the dimensions is shown by the engraving.

Locomotives on Prussian Railroads.—At a recent meeting of the German Society of Mechanical Engineers, Privy Counsellor Stambke gave the following information respecting the experience had on the Prussian State Railroads with the 519 compound locomotives in use thereon, and the conclusions arrived at by the mechanical officers respecting future locomotive construction: "All compound locomotives, under similar circumstances, when under full headway, develop a greater capacity than ordinary locomotives; at the same speed they exert greater traction, or with the same traction they make greater speed. They save fuel and water. On the other hand, ordinary locomotives have greater starting power than compounds, and, therefore, attain their standard rate of speed quicker. The time and space required for them to get under way is therefore less than with compounds, which latter, when stops are frequent, often find it difficult to make up the time lost in starting. A compound locomotive which is arranged to use steam like any ordinary one in starting can get under way as well as the latter. It is harder to start tight-coupled express and passenger trains than freight trains, and a failure of the draft-rigging, and a consequent lengthening of the time of getting under way, is therefore to be feared more with the former. The Prussian State Railroads have, therefore, come to the following conclusions: 1. Express locomotives hereafter are to be generally constructed on the compound system. 2. In all tank locomotives and engines for branch roads the compound system is to be excluded. 3. For freight engines used chiefly for long runs the compound system is to be employed. 4. For freight engines used chiefly to serve among the coal districts, the compound system will be avoided for the present. 5. For passenger engines with tenders, in view of the fact that they must make frequent stops, no decision is made yet. The experiments will be continued."

The Invention of the Telephone.—According to *Nature*, Professor D. E. Hughes, F.R.S., in the course of a few remarks made at the recent banquet given by the staff of the National Telephone Company, some points in connection with the early history of telephony were mentioned. The text of the speech is published in the *Electrical Engineer* for March 22, and the following note from it is interesting. Professor Hughes said:

"The earliest record of a perfect theoretical electric telephone was contained in Du Moncel's 'Exposée des Applications,' Paris, 1854; when M. Charles Bourseul, a French telegraphist, conceived a plan of conveying sounds and speech by electricity. 'Suppose,' he explained, 'that a man speaks near a movable disk sufficiently flexible to lose none of the vibrations of the voice, that this disk alternately makes and breaks the current from a battery; you may have at a distance another disk which will simultaneously execute the same vibrations.' Unfortunately M. Bourseul did not work out his idea to a practical end, but these few words contain the shortest possible explanation of the theory of the present telephones."

It is now exactly 30 years since Professor Hughes first experimented with a working telephone. In 1865, being at St. Petersburg in order to fulfil his contract with the Russian Government for the establishment of his printing telegraph instrument upon all their important lines, he was invited by his Majesty the Emperor Alexander II. to give a lecture before his Majesty, the Empress and Court at Czarskoi Zelo, which he did; but as he wished to present to his Majesty not only his own telegraph instrument, but all the latest novelties, Professor Philip Reis, of Friedericksdorf, Frankfort-on-Main, sent to Russia his new telephone, with which Professor Hughes was enabled to transmit and receive perfectly all musical sounds, and also a few spoken words, though these were rather uncertain, for at moments a word could be clearly heard, and then from some unexplained cause no words were possible. This wonderful instrument was based upon the true theory of telephony, and it contained all the necessary organs to make it a practicable success. Its unfortunate inventor died in 1874 almost unknown, poor and neglected; but the German Government have since tried to make reparation by acknowledging his claims as the first inventor, and erecting a monument to his memory in the cemetery at Friedericksdorf.

The Force of the Blast from an 8-in. Gun.—Recently, with a view to the practical determination of the effect of a blast from heavy gun firing over a protective plate, Commodore Sampson had a series of experiments made at the Indian Head Proving Ground. The Indian Head experiments were interesting, and are the first of the kind ever held in this country or abroad. Lieutenant Mason, the officer in charge of the proving ground, conducted them. An 8-in. gun was employed. Under its muzzle was placed a 7-in. armor-plate, which was 8 ft. square, and weighed about 8 tons. The centre of the plate was 20 in. in front of the muzzle and about 4 ft. below it. Over the plate, and nearly parallel with it, was secured a 1-in. wrought-iron plate, 74 in. long × 68.5 in. wide. It weighed about two-thirds of a ton, and was supported at each corner by a 2-in. armor bolt, screwed into the corner holes in the back of a 7-in. plate below. The corner holes in the bottom of the plate were not directly below the holes in the corners of the wrought-iron plate. Consequently they were bent to bring their upper ends into proper position. The centre line down the length of the 1-in. plate was parallel with the axis of the bore of the gun, prolonged .25 of an inch to the right and 24 in. below, the surface of the plate being inclined 1° with the horizontal, the same as the gun. The muzzle of the gun projected from the rear of the 1-in. blast plate 17.5 in. Two rounds were fired.

In the first round the charge of powder was 100 lbs., the muzzle velocity 2,018 foot-seconds, and the pressure 16 tons. The elevation of the gun was 1°. The wrought-iron 1-in. plate was bent downward at right angles to the line of fire, along its central transverse line, the centre of the plate being forced down by the blast 3.93 in. A slight rotary movement to the left was also given to the plate. The 7-in. armor was not moved at all. In the second round the charge of powder was 107 lbs., the muzzle velocity 2,000 foot-seconds, and the pressure and elevation the same as in the preceding round. The blast plate was in the position produced by the first round. The effect of the second blast was merely an augmentation of that of the first fire. The lower plate was not moved in the least. After the second round the support of the right-hand rear corner retained nearly its original position. The other three bolts had twisted to the right nearly 45°. The second round crushed the plate downward about 7 in., making the extreme deflection about 10 in.

The North Sea and Baltic Canal.—The canal is a little over 61 miles in length, and is throughout on the same level as the Baltic, where tides are unknown. Hence only two sets of locks have been necessary, one at each end, and even of these two the Holtenau locks may be treated almost as non-existent, as their gates will have to be closed only on the occa-

sion of storms on the Baltic affecting the height of the waters there—say on twenty or twenty-five days in the year. Thus for vessels proceeding westward there will be an absolutely clear and unobstructed course as far as Brunsbüttel, and here, except for three hours each day at ebb tide, the lock-gates will have to be kept closed on account of the tidal changes in the Elbe, though vessels will be able to pass through at any time, subject to the ordinary delays. The breadth of the canal at the water-level is 197 ft. and at the bottom 72 ft. 1¾ in., thus allowing of a man-of-war and any ordinary merchantman passing one another wherever they may happen to meet, while at six different points along the line of route there are "bays," where the increase of superficial breadth from bank to bank to 328 ft. and of the bottom breadth to 197 ft. for a distance of 820 ft. will allow of the passing of two men-of-war without fear of collision. The depth of the canal is 29 ft. 6 in. The old Eider Canal, which has been incorporated in the new one as far as Rendsburg, save for various windings, now happily avoided, had besides its six sets of locks a depth of only 10 ft. and a breadth of a little over 100 ft. The superiority of the new canal, with its far greater dimensions, almost unobstructed course, and its outlet into the Elbe at a point where the river has a depth of about 40 ft., is clearly manifest.

As regards the work of construction, the most interesting feature is perhaps to be found in the great terminal locks, and of these the locks at Brunsbüttel claim first consideration. They are protected from the current of the river by two moles, the heads of which are 1,247 ft. apart, thus allowing a good space for entrance into the outer harbor, which has a breadth of 328 ft. and a length of 1,312 ft. Here the vessels that may have to wait their turn before passing through the river will be accommodated. The locks themselves are double, the one set lying parallel with the other, divided by some massive masonry, under which are several tunnels for the hydraulic machinery to be used for opening or closing the gates and other purposes. The width of each lock is 82 ft., the depth 30 ft., and the available length, when the gates are closed at each end, is 492 ft.—dimensions adequate to allow of the passing through the locks at any state of the tide of the largest ironclads.

The Properties of Coal as Fuel for Steam Boilers.—Some manufacturers usually require their coal merchants to furnish material which shall contain (1) a certain proportion of lumps, (2) a small proportion of ash, (3) a certain percentage of volatile material, usually about 20 per cent. Accordingly the pit-owners only guarantee these three elements.

The moisture contained in the coal is of considerable importance, and also its freedom from stones and slate; but perhaps the number of heat-units generated by complete combustion is the best measure of the value of a coal. Lump coal has a greater calorific value than small coal or dust. It is proposed that lump coal be defined as that which is retained on a sieve of 1.4 in. mesh.

All coal—even coal fresh from the mines—contains a certain amount of moisture, from 1 per cent. to 6 per cent., which is not altogether unfavorable for combustion; the percentage of moisture must not, however, fall outside certain limits. Some railway companies pay only for the dry coal, and make a moisture test on all coal received, rejecting that in which the moisture exceeds 7 per cent.

The quantity of ash and cinder is of great importance; not only has this to be paid for and transported, but on being put into the furnace it hinders combustion and adds considerably to the work of the stokers. The railway companies specify 6–8 per cent. of ashes and cinders, pay 0.5 franc per ton for 1 per cent. less, and deduct 0.5 franc per ton for 1 per cent. more, and reject any delivery containing more than 10 per cent. ash and cinders.

The proportion of volatile components influences the ease of kindling the coal and the quickness with which it burns. In sugar works 20–22 per cent. of volatile components is demanded. If the draft is strong 15 per cent. may be sufficient, while with weak draft 25–28 per cent. is required. A coal containing too much volatile material burns too quickly without giving up usefully the heat due to its combustion. A mixture of two coals containing respectively too little and too much volatile material should be rejected. The wider commercial use of calorimeters is recommended, a coal giving less than the specified number of calories to be rejected.

The fusibility of the clinker is an important point to be considered, the author stating from his own experience that coal which, in a lightly worked boiler with weak draft, gave no fused clinker, in a hard forced boiler with strong draft gave a considerable quantity of clinker.

A specimen form of contract for coal is given at the end of the paper.—*Abstract of article in Mittheilungen aus der Praxis der Dampfkessel- und Dampfmachinen-Betriebes*, 1894.

Smoke Prevention.—The serious difficulty with nearly if not quite all the appliances which have been devised for consuming smoke is that they do not pay. The heating capacity of smoke is so little, that it is cheaper to waste the smoke than to utilize the small amount of potential heat there is in it; besides this, some portions of the smoke are incombustible. Colonel Dulier has devised a system of smoke prevention, which has been described in the London *Times*, by which the smoke after leaving the furnace is mixed with steam in an ascending flue, and then in a descending flue is met by a very fine spray of cold water. The result is that the larger part of its constituents are dissolved or precipitated, and escape with the water into the drains, from a tank at the bottom of the descending flue. Any residue passes out with a certain amount of steam from a chimney fixed in the tank. A rough proof of the efficacy of the arrangement is afforded by the fact that a piece of white cloth may be held for some minutes over the top of this chimney without becoming appreciably blackened.

Colonel Dulier's apparatus is in use at the City Saw Mills, Glasgow, and at Messrs. Merryweather's factory at Greenwich, and is being fitted to the Opera in Paris. At Messrs. Merryweather's the smoke from 11 forges is collected in one main flue, and after being mixed with steam is subjected to the action of three water jets consuming 100 galls. of water an hour. The system is here found so satisfactory that the rest of the forges are shortly to be connected, and it is considered that the same amount of water will be sufficient to treat the smoke from them also. From observations made by the Public Analyst of Glasgow at the Saw Mills, it appears that the apparatus there removes over 90 per cent. of the solid matter of the smoke and more than half the sulphurous acid. It does not affect the draft in the chimney, any loss caused by the bends of the flues being compensated by the effects of the jet of steam which damps the smoke. In Glasgow this jet is at a pressure of 80 lbs. to 100 lbs. per square inch, but though a fairly high pressure both for the steam and water jets seems to be advantageous, yet it is not necessary. The apparatus has been fitted to a stack of chimneys in a house in Belgravia, and has worked satisfactorily, using the water from the mains, and the steam given off by an ordinary high-pressure hot-water boiler. It is even said to have resulted in a reduction in the amount of coal burnt. There is an incidental advantage connected with it which may commend itself to people who are solicitous about sanitation. The water which has been used in the flue contains a quantity of sulphurous acid, and is, therefore, a disinfectant of considerable power. The cost of construction ought not to be very great, since the flues are only large steel tubes. But if the apparatus fulfils all that is claimed for it, manufacturers might find themselves recouped for their outlay by being able to burn an inferior and cheaper coal without producing an improper amount of smoke.

Trials and Performance of French Warships.—A correspondent of the London *Times* writes: "Toward the close of last year French dockyards had to report very unsatisfactory results given by certain warships at their trials. The armored cruiser *Latouche-Tréville*—in the performances of which considerable interest is felt because she is fitted with Belleville boilers—had failed to develop the H.P. expected, the *Dupuy de Lôme* was still giving much trouble, and the *Fleurus* stood in need of considerable repairs after her mishaps. In contrast to this disappointing state of things is the series of successful trials more recently made. Some of the trouble given by the *Latouche-Tréville* is probably due to the fact that, like her sisters, the *Bruix*, *Chanzy* and *Charner*, she has been built upon a displacement (4,660 tons) too near the *minimum* for her offensive and defensive power; but she is a splendid cruiser, and will attract attention during the summer campaign of the northern squadron. With 7,400 H.P. she attained in February a speed of 17.5 knots; but when 8,450 H.P. was developed in the first official trials she steamed at 18.16 knots under the easiest conditions. The cruiser *Dupuy de Lôme* (6,600 tons), after her long series of mishaps, completed her trials at Brest early in April, attaining the high mean speed of 19.8 knots. The *maximum* rate was 20.4 knots, and it seems likely that 20 knots would have been maintained save for the inefficient stoking of one of the boilers. The mean revolutions of the middle screw were 135, and of the lateral screws 139. The *Dupuy de Lôme*, with her practically complete coating of armor, will certainly be one of the most remarkable vessels present at the opening of the North Sea and Baltic Canal. Another cruiser which has given very satisfactory results in March is the *Friane*, a protected vessel of 3,772 tons, built at Brest under the direction of M. Dugi de Bernonville. Her machinery has been constructed by the Forges et Chantiers de la Méditerranée, and the boilers, upon the Niclausse water-tube principle, are from the works of the company so named. The advantage

claimed for this system is that it enables the tubes to be reached easily. The mean speed in a rough sea was 18.8 knots, but during some runs a speed of 19.3 knots was attained and 9,503 H.P. was developed instead of the contract pressure of 9,000 H.P. The coal consumption also was small. The *Valmy*, coast-defence armorclad (6,590 tons), and sister of the *Jemmappes*, is giving satisfactory results at Brest, where, during a two-hours' forced draft run, she attained a mean speed of 16.71 knots at the end of March. Another sister, the *Bouvines*, has also entered upon her trials with great promise. These are the three armorclads which are to constitute such a powerful fighting unit in the northern squadron, and, as Admiral Besnard has told both the Chamber and the Senate, they are well fitted for the use of the ram by reason of their small turning circles and powerful build. Another vessel which has just attained a satisfactory trial speed (mean of 27 knots) at Brest is the sea going torpedo-boat *Lansquenet;* but the bottom of one of her cylinders, as had been foreseen, gave way, and she returned to port for repairs."

Water-tube Boilers in the British Navy.—The following brief abstract, which was published in *The Times*, of a discussion of a paper on The Machinery of War Ships, by Mr. A. J. Durston, which was read before the Institute of Civil Engineers, will be of interest to many of our readers.

The point in the paper which perhaps attracted most attention was the introduction of water-tube boilers of different types into some of the ships built under the Naval Defence Act. Sir Edward Reed remarked that the paper contained the cream of the present knowledge of this type of boiler. Mr. Thorneycroft contended that in them was the best chance of reducing the weight of the propelling machinery of ships and of obtaining speed with lightness. It was impossible, he thought, to do much more than has already been done in reducing the weight of the engines, while we had, perhaps, sacrificed a little too much in the way of fuel. But real advance might be made in the boilers. Both the forms of tank boiler now in use—the locomotive and the drum—were heavy, and the paper contained evidence that they had been worked to their limit. The Belleville boiler, as fitted in the *Sharpshooter*, was a step in the right direction, but was still too heavy. He proceeded to give some figures concerning the weights and heating surfaces of the different types of boiler, showing that water-tube boilers weighed much less per square foot of heating surface than drum or locomotive boilers. Mr. Seaton pointed out that water-tube boilers would stand rough usage without sustaining the damage to which tank boilers would be liable. In war it would sometimes be necessary to get up steam quickly, and there would be no time for the "nursing" required by tank boilers. But steam could be got up very quickly in water-tube boilers without injury to them. As regards forced draft, Mr. Thorneycroft considered the last-mentioned type to be superior to drum boilers, which, sooner or later, he said, gave out under it. For short voyages at high speed he held that forced draft was essential, though for long voyages he believed in ample heating surfaces and no forced draft. The question of forced against induced draft was also discussed. Some speakers believed there was a future for induced draft, while others could not see that it makes much difference whether air is blown in at one end of the furnace or sucked out at the other. The air-pumps in all the new boats are worked off the main engines, and it was suggested that independent air-pumps (which had been tried in the United States Navy) would be an improvement. Mr. Seaton was strongly opposed to them. In the first place, they took up too much room, and, in the second, were the most difficult of all pumps to control. Sir Edward Reed inquired about the difference he observed between the ratios of the high and low pressure cylinders in the Navy and the mercantile marine. Mr. Durston, in reply, pointed out that warships had often to run for long periods at low power, and it was believed that a small ratio between the cylinders in such cases produced the most economical results. With regard to the variety of practice observable in the construction of engines and boilers in different ships, Mr. W. H. White remarked that these vessels were built by private firms who, while subject to certain general conditions laid down by the Admiralty, yet had a free hand in many points. Mercantile practice and naval practice reacted on each other to the advantage of both; an example might be found in the effect which the adoption of forced draft in the Navy had had on mercantile practice. In criticising warships it must always be borne in mind that they are made to be fighting machines, and that everything in them must be subordinated to that function. Mr. White also asked critics to believe that for every arrangement carried out in them there was a reason of some kind, and that nothing was done merely from "cussedness" on the part of the designers and engineers.

THE TEHUANTEPEC RAILROAD—ITS IMPORTANCE AS A COMPETITOR FOR TRANSCONTINENTAL TRAFFIC.

To the Editor of THE AMERICAN ENGINEER:

The announcement received some few days ago by cablegram from Mexico, that Congress has approved and ratified the contract made by the Executive Government with Messrs. Samuel Hermanos, of Mexico and New York, for the furnishing of $2,000,000 worth of rolling stock, bridges, lighters, tugs, and other equipment for the Tehuantepec Railroad, calls attention once more to the great problem of curtailing the time required for the transportation of passengers and freight between the principal commercial cities of the Eastern and Western Hemispheres.

The present century has been very prolific of schemes for transforming the physical character of certain portions of the universe, with the sole object of bringing together remote regions of the globe, the intimacy of whose commercial relations has been much handicapped by the lack of facilities for rapid transportation. It is only necessary to refer to some of the great engineering enterprises, such as the Suez Canal, the ill-fated Panama Canal, the projected Nicaragua Canal, the transformation of the Isthmus of Corinth into an ocean waterway; the conversion of the great manufacturing emporium of Manchester into a seaport town; and, at more recent date, the completion of the great ship canal in the Baltic Sea, and last, but not least, the completion of the Tehuantepec Railroad, after so many years of vicissitudes, to realize at once the vastly important *rôle* which the question of rapid transportation plays in the development of international commerce.

The Tehuantepec Railroad has met with so many misadventures, has had to struggle so frequently with financial difficulties, and has suffered such protracted delays in its final completion, that the real significance of its bearing upon the future of international commerce, while so thoroughly realized by its original projectors and by the Mexican nation, has not awakened in the minds of the present generation the interest to which its importance entitles it, principally because the quiet and unpretentious way in which its completion has been brought about has hidden its light behind a bushel, so to speak, and the outside world of the present day has been quite unconscious of the potentialities which are now about to be laid bare by the entry of the Tehuantepec Railroad into the field of international transportation.

The circumstances surrounding this achievement, and the innumerable vicissitudes through which it has passed, make very interesting reading to those who are inspired by the story of great commercial and financial enterprises, and, when the last page of its history has been written, the whole volume will be found to contain much that furnishes an eloquent tribute to the masterful genius, political sagacity, and patriotic perseverance of General Perfirio Diaz and those of his official associates into whose hands have been confided the destinies of Mexico during the past fifteen years.

The present generation, however, is most deeply concerned with its importance as a commercial enterprise, and, in this connection, it will suffice to refer to the following table, compiled from the Board of Trade returns of the Foreign Commerce and Navigation Section of the United States Treasury, showing the comparative distance between some of the principal of the world's shipping ports by way of Panama and the Tehuantepec route respectively:

	Via Tehuantepec R. R.	Via Panama R. R.
	Miles.	Miles.
New York & Hong Kong	11,597	11,645
" " " Auckland	9,345	9,313
" " " Melbourne	11.068	11.471
" " " Honolulu	6,566	7,705
" " " San Francisco	4,925	6,107
Liverpool " " "	8,274	9,071
New Orleans " "	3,561	5,415
" " & Auckland	7,981	9,426
" " " Honolulu	5,202	7,182
Liverpool & Yokohama	13,224	14,175
" " Melbourne	14,113	14,435
" " Auckland	12,584	12,777
" " Honolulu	9,805	10,670

In short, if a comparison is made with the Tehuantepec Railroad on 16 of the main routes of commerce between the East and the West, it will be found that the total saving by this route is over 125,000 miles.

It is understood that Messrs. Samuel Hermanos, who have so successfully carried through the contract above referred to, are likewise negotiating for the work of dredging the ter-

minal harbors at Coatzacoalcos and Salina Cruz, and constructing wharves and jetties on each side of the coast. As the work to be accomplished is one which is peculiarly fitted to the structural genius and enterprise of many well-known contractors of this country, and there is, we are informed, a good opportunity for much if not all of this work to be carried out with American capital and American enterprise on a very remunerative basis, it will doubtless be interesting to many of our readers to learn briefly the character of the work to be accomplished; and the conditions that have to be dealt with.

Mr. Corthell, an eminent engineer, who was closely identified with the construction of the Tehuantepec Railroad during its final stages, under the supervision of the Mexican Government, and who has had many opportunities of thoroughly investigating the important works yet to be accomplished, contributed some time ago a very interesting article to the *Engineering Magazine*, of New York, and we acknowledge our indebtedness to this article for some of the data furnished herein.

The route across the neck of land known as the Isthmus of Tehuantepec is very much shorter than that by the Isthmus of Panama, and lies through a country possessing a good climate and very encouraging prospects of a profitable local traffic. The physical character of the country traversed by the line is somewhat varied, being very level in some points, and in others very mountainous. In the mountainous regions the maximum grade does not exceed 2 per cent., while that on the tableland, running through an ordinary rolling country, does not exceed 1.8 per cent.

Five large rivers, of much importance to the surrounding country both for irrigation and navigation purposes, are traversed by the line, and there is only one tunnel, about 300 ft. in length. The line has been well and solidly laid, on a good roadbed.

The equipment now being built will furnish the necessary facilities for handling a vast amount of transcontinental traffic, and the realization of this project will be fully and finally accomplished when the harbor works, to which the above-mentioned contract has reference, shall have been brought to a satisfactory conclusion.

The terminus of the Gulf Coast is at the mouth of the Coatzacoalcos River, having a watershed area of about 6,500 square miles. The river enters the Gulf between two headlands, one composed of sand-dunes, and the other of solid rocks about 60 ft. high. The bar at the mouth of the river is an obstruction at the present time to the crossing of vessels drawing more than 11½ or 12 ft. of water, but the continued flow of fresh water excavates a deep channel through this bar at the present time.

The Engineering Department of the Mexican Government has laid out various projects from time to time, and is even now at work upon a final scheme, the result of the last survey made by very competent engineers. It is possible that the final plans will not differ materially from those which have been set forth up to date, and the following particulars will convey a very accurate idea of what is to be accomplished.

On the Gulf Coast it is proposed to build parallel jetties extending 4,500 ft. from the shore to about 34 ft. deep in the Gulf, with a distance between the two jetties of about 800 ft. The permanent structures are to be built entirely of rock.

The considerations upon which these plans have been based have been largely determined by the fact that there is a constant sea current with a velocity of from 1 to 3 miles an hour entering the Gulf of Mexico between the peninsular of Yucatan and the island of Cuba. This current hugs the coast-line, so to speak, throughout the whole extent of the mainland, past the mouth of the Coatzacoalcos River, Vera Cruz, and Tampico, and the concave configuration of this coast-line intensifies somewhat the effect of the current upon all of the Gulf harbors and riverways.

It is proposed to build a wharf parallel to the shore, and running a distance of about 2,000 ft., either of creosoted timber, or of piles, or of steel. In consequence of the steep slope of the bank, this wharf need not be more than 100 ft. wide from the shore-line in order to run into deep water.

The equipment contract, above referred to, includes the furnishing of the necessary tracks, warehouses, and complete hydraulic plant for handling freight quickly and economically from the vessels to the cars.

The structural work to be built on the Pacific coast is somewhat different in character, and consists mainly of a breakwater of broken stone, coped with concrete blocks. The question of dredging does not enter on this side, because the slope of the shore under water is quite steep, and there is at all times considerable depth of water. What is mainly required is the construction of a protected and quiet harbor, to enable ships of all sizes to anchor under the most tempestuous conditions and during the prevalence of the strong winter northers.

It is estimated that the jetties and auxiliary works in Coatzacoalcos Harbor will cost about $2,250,000, and the proposed terminal wharf, with its warehouses, tracks, and hydraulic plant, will cost about $360,000. The estimate of expenses of the Salina Cruz works, comprising the breakwater terminal piers and dredging, will amount to about $3,085,000, making a total for both harbors and terminal works of $5,695,000 gold.

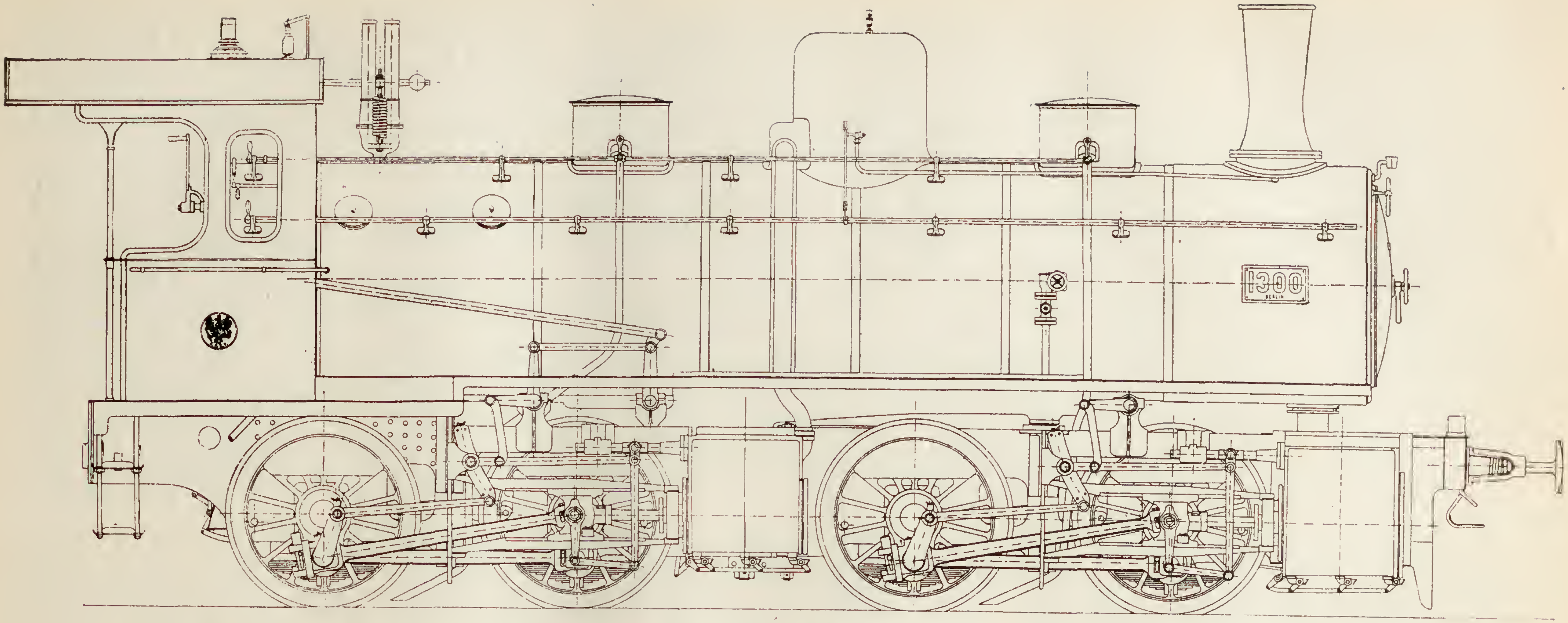
It is understood that the general terms of the contract, including the conditions of payment, while reflecting great credit upon the financial stability of the Mexican Treasury, and the broad-minded and comprehensive judgment of those who have outlined the basis of the project, will prove very remunerative to all parties who will ultimately be engaged in carrying the works to completion and liquidating the financial transactions involved therein.

British financiers and contractors are usually much better equipped from the outset to tackle these large contracts, because they are always safe to proceed upon the assumption that all such undertakings, if they contain the elements of a substantial and remunerative enterprise, will at once command the support of financial institutions, and the co-operation of contractors to meet all legitimate and reasonable requirements needed by a country whose material development depends upon the fructifying assistance of foreign financial aid.

The general ignorance prevailing in this country with regard to the important *rôle* which Mexico is destined to play in the battle for commercial supremacy, and more particularly the true inward significance of the possession by Mexico of this important key to traffic between the Eastern and Western Hemispheres, is largely responsible for the supineness and indifference of financial institutions in this country toward lending their aid to the development of its important public works. It is time that the people of the United States should realize that Mexico is a country of vast natural resources, which absorb the investment of foreign capital only to return it tenfold, and that it is no longer a sign of great astuteness to regard Mexico as a country always on the brink of a revolutionary volcano, but rather a sign of the most crass and obstinate stupidity to blind one's eyes to the fact that fifteen years of absolute political tranquillity, the construction of 12,000 miles of railroad, of 20,000 miles of telegraph lines, and the development of vast industrial enterprises, as much with American as with native and European capital, have planted, so to speak, at the door of every inhabitant of the country, a material interest which makes for peace and the tranquillity required for industrial and commercial development, and has annihilated altogether these negative conditions wherein revolutionary outbreaks might have been regarded as a species of Pandora's box, full of encouragement to the disaffected elements that were rampant before the development of the political and industrial development of the country had given them that which they required to ally themselves closely with the nation's prosperity.

The present significance of the Tehuantepec Railroad can be seen in the effect which it will have upon the trade with the European nations and the Pacific coast-line of America, as well as between the United States and Asiatic ports, and the nature of this effect is amply demonstrated by a consideration of the time required for freight by various routes which have been thoroughly investigated with the following results:

Transportation from San Francisco by fast freight line to New York *via* Southern Pacific to New Orleans, and thence by water to New York, covering a distance of about 9,286 miles, is accomplished in 14 days. It takes 140 days to cover by sail the distance of 15,420 miles around Cape Horn; 60 days by steam along a route of 13,000 miles *via* the Straits of Magellan; 25 days *via* Transcontinental line fast freight over a distance of 10,203 miles, and only 20 days *via* the Tehuantepec Railroad, a distance of 4,280 miles. A comparison of the time and distance of all rail routes by the time and distance of half rail and half ocean routes *via* New Orleans, at once demonstrates the importance of this new Tehuantepec route as a competitor for the class of traffic, for it is mainly on account of the facts brought out by this comparison, and of the absence of the Tehuantepec Railroad as a factor in this trade, that the Southern Pacific and Morgan Line *via* New Orleans has been able to obtain from 75 to 90 per cent. of the entire transcontinental traffic, and dictate their own terms to competing lines. There is very little doubt that the great advantages of a geographical, physical, nautical, and commercial character possessed by the Tehuantepec Railroad route over those of Cape of Good Hope, Suez Canal, Cape Horn, Straits of Magellan, Panama, Nicaragua, and Transcontinental Line will rapidly divert a large share of existing traffic over this new line.



SIDE ELEVATION OF EIGHT-WHEELED COMPOUND LOCOMOTIVE FOR THE PRUSSIAN STATE RAILWAYS.

EIGHT-WHEELED COMPOUND FREIGHT LOCOMOTIVE FOR THE PRUSSIAN STATES RAILROADS WITH FRONT STEAM-TRUCK.

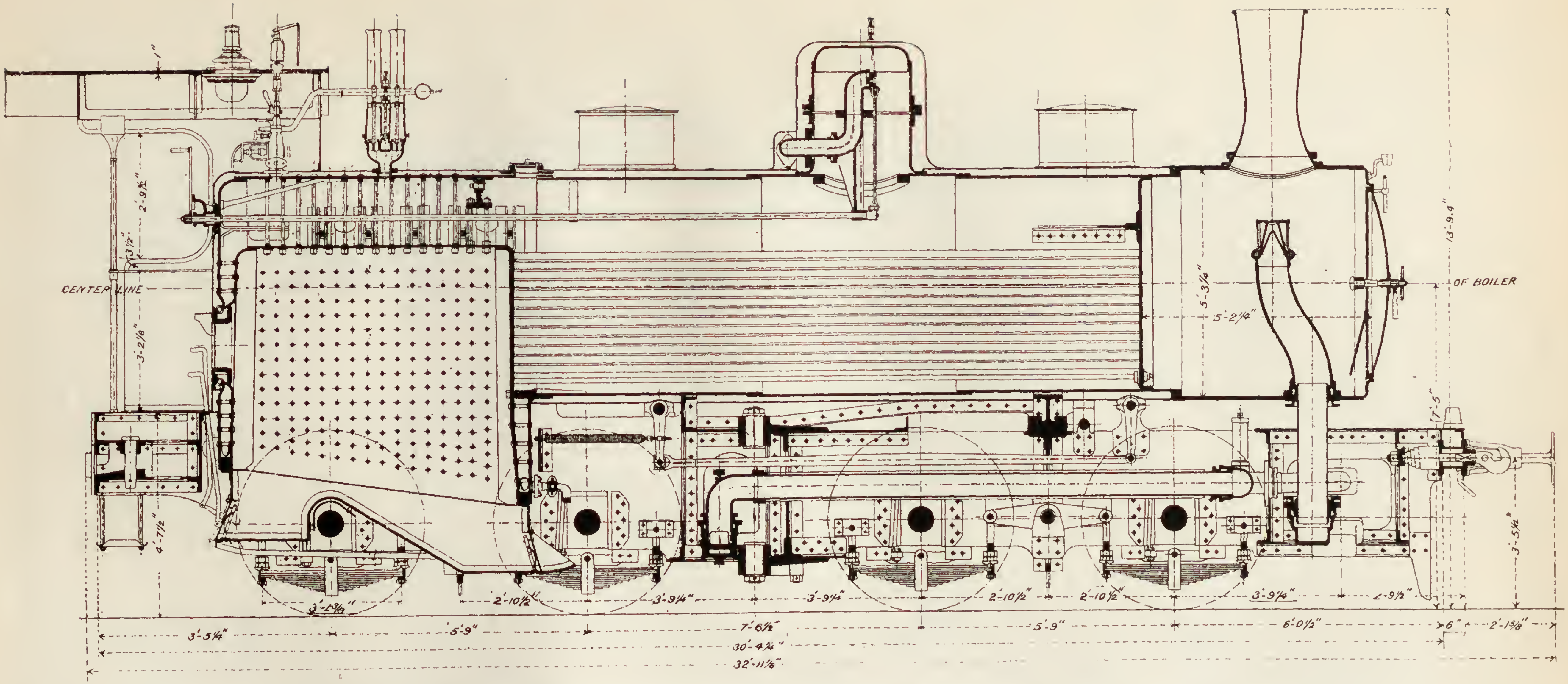
WE reproduce from a recent issue of *Glaser's Annalen* the engravings of an adaptation of the Fairley type of locomotive that is now in use on the Prussian State Railroads. As will be seen from the illustrations, the locomotive is carried upon eight wheels coupled in sets of four, and each set driven by a separate set of engines. Those at the back, which are in the rigid portion of the frame, are driven by a pair of high-pressure cylinders $15\frac{3}{4}$ in. in diameter and 23.6 in. stroke. As these cylinders are rigidly fastened to the boiler, steam is brought to them directly from the dome by pipes coming down on the outside of the boiler lagging, and which branch out from the stand-pipe immediately back of the dome.

The front set of four drivers with the low-pressure cylinders are carried on a Bissell type of truck that is pivoted midway between the forward drivers of the back set and the back drivers of the forward set, with a sliding bearing against the bottom of the boiler midway between the two forward pairs of drivers.

The exhaust-pipe from the high-pressure cylinders is pivoted in a stuffing box just back of the pivot-pin of the truck, and the inequalities in distance between this point and the forward cylinders, due to the distance between centres, is compensated for by an expansion joint at the front end of the exhaust-pipe or receiver by using an ordinary stuffing-box at this point. The low pressure cylinders have a diameter of $23\frac{5}{8}$ in., and a stroke of 23.6 in. Thus the relative area of the two sets of cylinders is as 1 to $2\frac{1}{4}$.

The stationary link is used to move the valves of the two sets of cylinders, both being operated by a single reach-rod controlled by the usual screw-reversing motion in the cab. The main reach-rod extends from the cab to an arm on a shaft just back of the cylinders. From this arm a short connection is made back to the lifting shaft lever of the high-pressure cylinders, while from an arm projecting downward from the auxiliary lifting-shaft a supplementary reach-rod extends forward along the centre line of the engine to the arm of the low-pressure lifting-shaft, as shown in the longitudinal section of the engine.

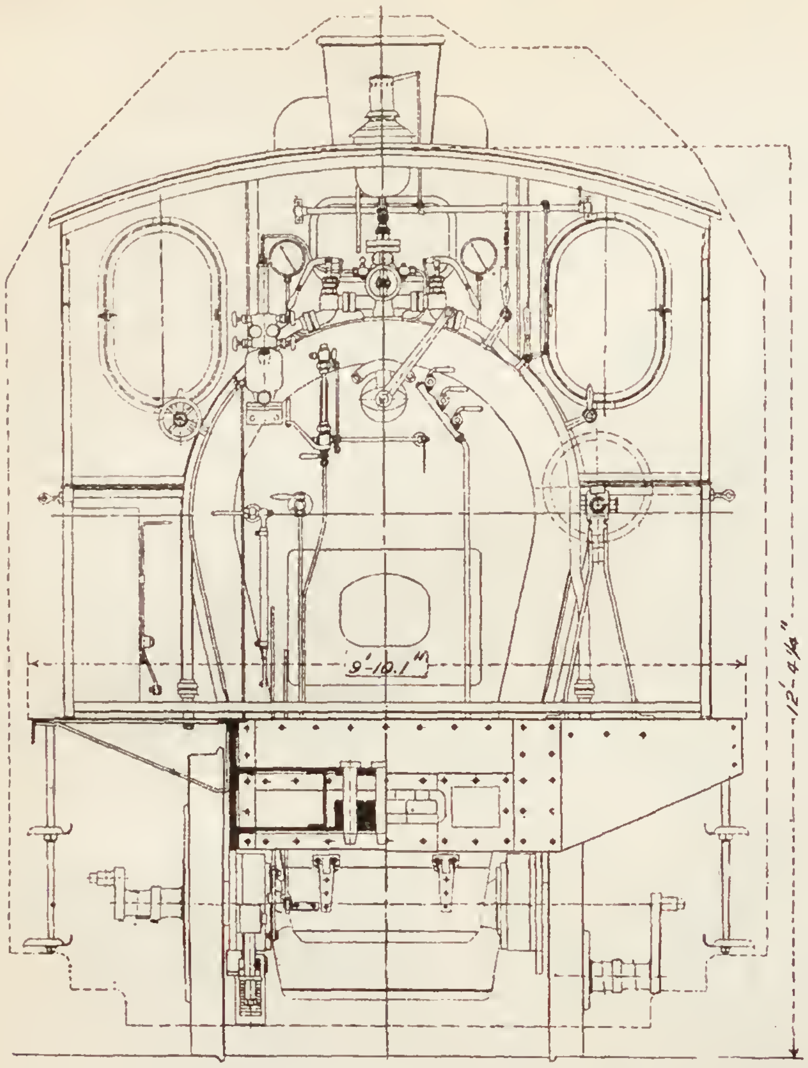
Referring to the cross-sections through the cylinders, the course of the steam from the dome to the stack can be very easily followed. As we have already said, it comes down on the outside of the boiler to the high-pressure steam-chests. The exhausts from these cylinders drop down to a point about on a level with the lower sides of their shells and at the centre of the boiler, whence it rises and passes through a long receiver pipe, as noted, to the low-pressure steam-chests. The exhaust from these cylinders also drops down quite low to allow for the introduction of a pipe to compensate for the side motion of the truck, and deliver the steam into a long blast-pipe in the smoke-box. In other respects the engine is fitted and equipped similar to the other engines of the Prussian State Railways.



LONGITUDINAL SECTION OF EIGHT-WHEELED COMPOUND FREIGHT LOCOMOTIVE FOR THE PRUSSIAN STATE RAILWAYS.

The following are some of the principal dimensions of this locomotive :

Weight upon the back H.P. driver springs in working order..........24,250 lbs.
Weight of back H.P. drivers, axle and attachments.... 5,512 lbs.
Total weight upon back H.P. driving-wheel tires in working order..........29,762 lbs.
Weight upon forward H.P. driver springs in working order.......... 24,823.3 lbs.
Weight of forward H.P. drivers, axle, and attachments. 5,370.2 lbs.
Total weight on tires of forward H.P. drivers in working order..........30,193.5 lbs.
Weight upon back L.P. driver springs in working order..25,242.2 lbs.
" of " " drivers, axle, and attachments.. 5,512 lbs.
Total weight on tires of back L.P. drivers in working order..........30,754.2 lbs.
Weight upon forward driver springs in working order..25,947 lbs.
" of forward drivers, axle, and attachments...... 5,258.15 lbs.
Total weight on forward driver tires..........31,205.15 lbs.
" " of locomotive in working order..........121,914.85 lbs.
" " " " empty..........106.902 lbs.
" wheel base.......... 5 ft. 9 in.
Distance between centres of L.P. drivers.......... 5 ft. 9 in.
" " " " H.P. " .... 3 ft. 9¼ in.
Distance from centre of L.P. cylinders to centre of forward drivers.......... 8 ft. 9¼ in.
Distance from centre of H.P. cylinders to centre of forward pair of H.P. drivers.......... 2 ft. 4½ in.
Transverse distance between H.P. cylinder centres..... 6 ft. 9½ in.
" " " L.P. " " .... 6 ft. 9½ in.
Diameter of H.P. cylinder.......... 15¾ in.
Stroke of H.P. piston.......... 1 ft. 11.6 in.
Diameter of L.P. cylinder.......... 1 ft. 11⅝ in.
Stroke of L.P. piston.......... 1 ft. 11.6 in.
Diameter of driving-wheels outside of tires.......... 4 ft. 1¾ in.
" " axle jonrnals.......... $7\frac{1}{18}$ in.
" " wheel seat.......... 7½ in.
Length of springs, centre to centre of hangers.......... 3 ft. 1¾ in.
Boiler.......... Straight top.
Inside diameter of smallest ring of barrel.......... 4 ft. 9⅝ in.
Thickness of plates in barrel of boiler.......... 0.7 in.
Number of tubes..........218
Diameter of tubes, outside.......... 2 in.
" " " inside.......... 1.8 in.
Distance between centres of tubes.......... 2.6 in.
Length of tubes between tube plates.......... 14 ft. 1.3 in.
" " fire-box.......... 6 ft. 2.8 in.
Depth " " front.......... 5 ft. 9.7 in.
" " " back.......... 4 ft. 11.8 in.
Width " " top.......... 3 ft. 7.3 in.
Water space, side of fire-box.......... 2¾ in.
" " back of fire-box.......... 4.9 in.
" " front of fire-box.......... 2¾ in.
Thickness of plates of outside shell of fire-box.......... ⅞ in.
" " side plates of fire-box.......... ⅝ in.
Material of inside of fire box..........Copper.



Rear Elevation Showing Clearances.

Thickness of plates, back end of fire-box	0.6 in.
" " crown-sheet	⅝ in.
" " back head of boiler	0.7 in.
" " front tube-sheet	1 in.
" " back	1.1 in.
Crown sheet stayed	By vertical stays.
Diameter of dome, inside	2 ft. 9 in.
Height " " "	2 ft. 10⅝ in.
Grate surface	20.9 sq. ft.
Heating surface in fire box	108.7 sq. ft.
" " " tubes	1,456.4 sq. ft.
Total heating surface	1,565.1 sq. ft.
Kind of blast nozzle	Single.
Height from top of rails to top of stack	13 ft. 9.4 in.
" " " " " " centre of boiler	7 ft. 5 in.
Kind of frame	Plate.
Distance between insides of frames	4 ft. 0.2 in.
Transverse distance between valve stems	7 ft. 8 in.
" " " side rods	5 ft. 10 in.
Width of engine over all	9 ft. 10.1 in.
Height of top of cab above rails	12 ft. 4¼ in.
" " foot plate above the top of the rails	4 ft. 7½ in.
Width of tires over all	5.5 in.

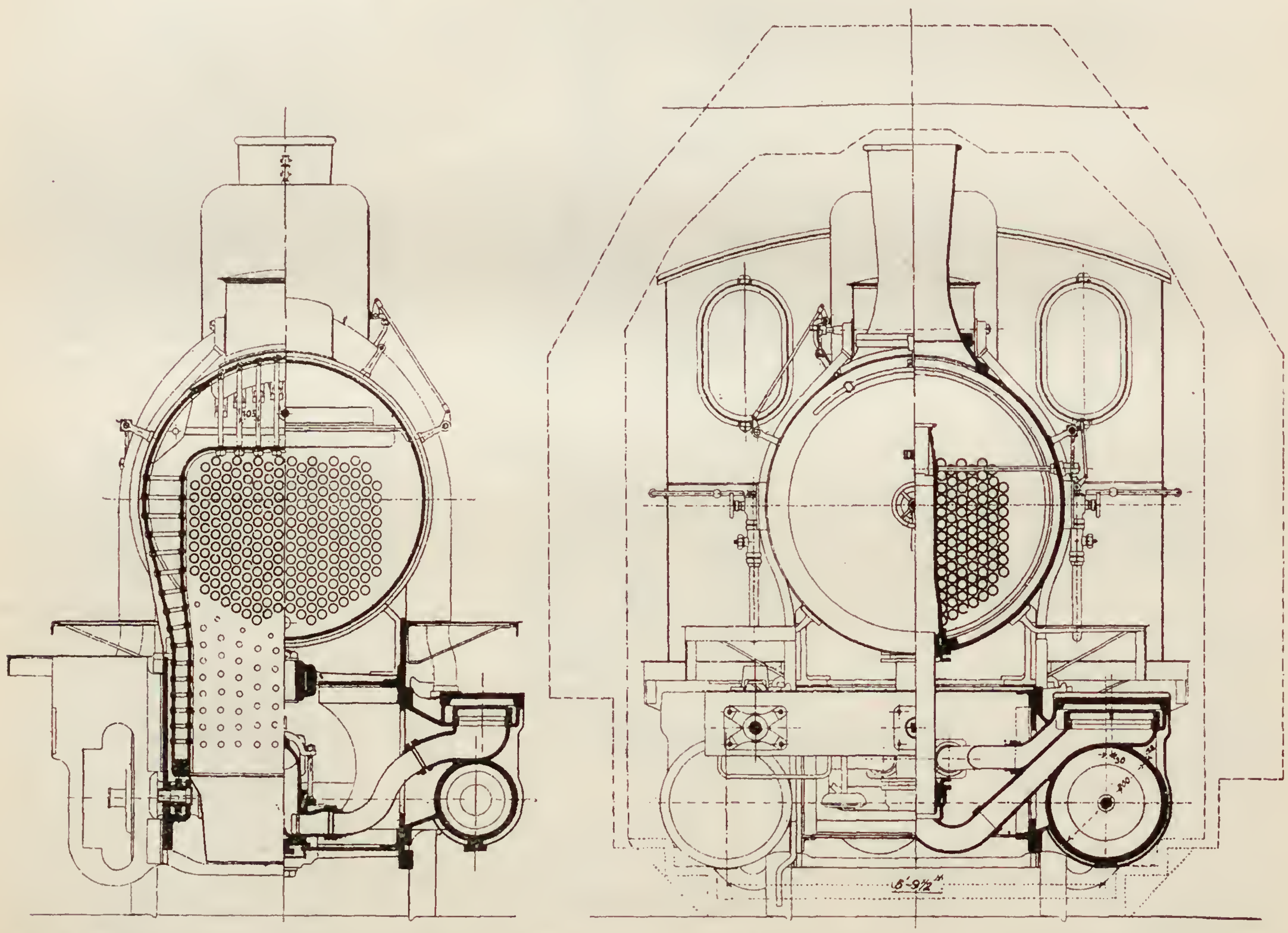
A PIECE-RATE SYSTEM, BEING A STEP TOWARD PARTIAL SOLUTION OF THE LABOR PROBLEM.*

By Fred. W. Taylor.

The ordinary piece-work system involves a permanent antagonism between employers and men, and a certainty of punishment for each workman who reaches a high rate of efficiency. The demoralizing effect of this system is most serious. Under it, even the best workmen are forced continually to act the part of hypocrites, to hold their own in the struggle against the encroachments of their employers.

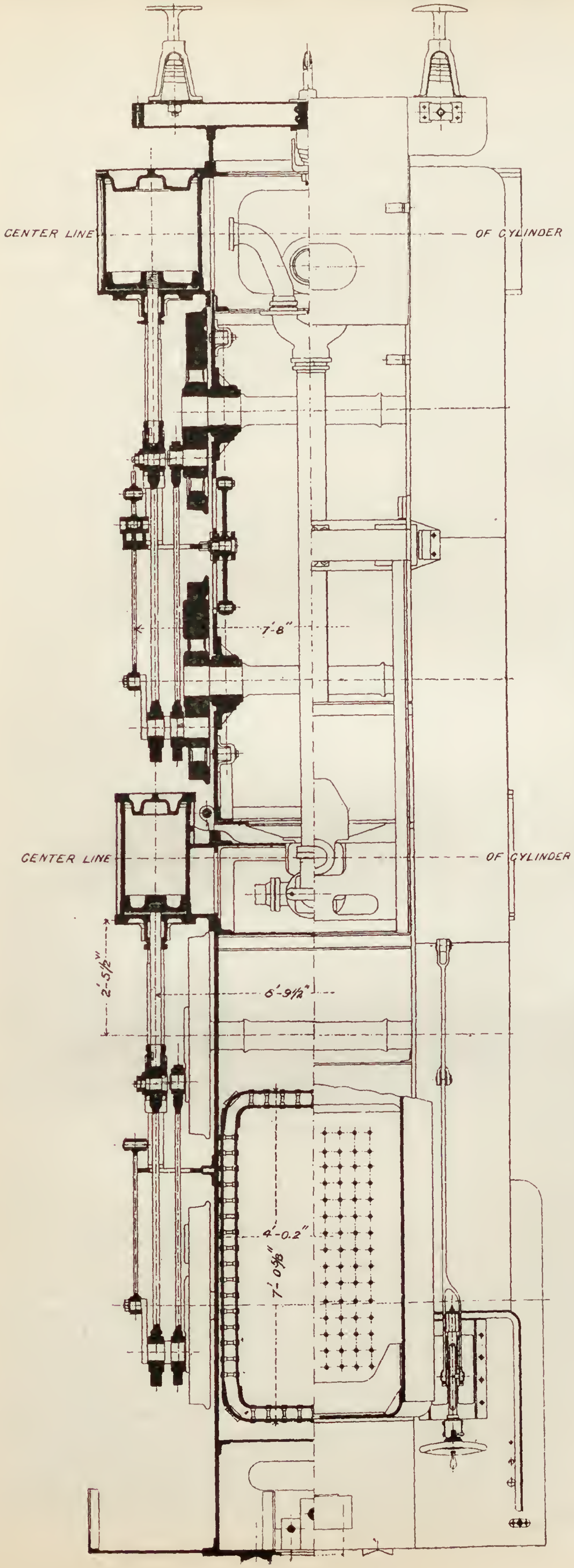
The system introduced by the writer, however, is directly the opposite, both in theory and in its results. It makes each workman's interests the same as that of his employer, pays a premium for high efficiency, and soon convinces each man that

* Extracts from a paper presented at the Detroit meeting (June, 1895) of the American Society of Mechanical Engineers.



Half Section at Fire-Box. Half Section at H. P. Cylinder. Front Elevation. Half Section at L. P. Cylinder.

EIGHT-WHEELED COMPOUND FREIGHT LOCOMOTIVE FOR THE PRUSSIAN STATE RAILWAYS.



HALF PLAN AND HORIZONTAL SECTION OF EIGHT-WHEELED COMPOUND LOCOMOTIVE ON THE PRUSSIAN STATE RAILWAYS.

it is for his permanent advantage to turn out each day the best quality and maximum quantity of work.

The writer has endeavored in the following pages to describe the system of management introduced by him in the works of the Midvale Steel Company, of Philadelphia, which has been employed by them during the past ten years with the most satisfactory results.

The system consists of three principal elements:

1. An elementary rate-fixing department.
2. The differential rate system of piece-work.
3. What he believes to be the best method of managing men who work by the day.

The differential system of piece-work consists briefly in offering two different rates for the same job: a high price per piece, in case the work is finished in the shortest possible time and in perfect condition; and a low price, if it takes a longer time to do the job, or if there are any imperfections in the work. (The high rate should be such that the workman can earn more per day than is usually paid in similar establishments.) This is directly the opposite of the ordinary plan of piece-work, in which the wages of the workmen are reduced when they increase their productivity.

The advantages of this system of management are:

1. That the manufactures are produced cheaper under it, while at the same time the workmen earn higher wages than are usually paid.

2. Since the rate-fixing is done from accurate knowledge, instead of more or less by guess-work, the motive for holding back on work, or "soldiering," and endeavoring to deceive the employers as to the time required to do work, is entirely removed, and with it the greatest cause for hard feelings and war between the management and the men.

3. Since the basis from which piece-work, as well as day-rates, are fixed is that of exact observation, instead of being founded upon accident or deception, as is too frequently the case under ordinary systems, the men are treated with greater uniformity and justice, and respond by doing more and better work.

4. It is for the common interest of both the management and the men to co-operate in every way, so as to turn out each day the maximum quantity and best quality of work.

5. The system is rapid, while other systems are slow, in attaining the maximum productivity of each machine and man; and when this maximum is once reached, it is automatically maintained by the differential rate.

6. It automatically selects and attracts the best men for each class of work, and it develops many first-class men who would otherwise remain slow or inaccurate, while at the same time it discourages and sifts out men who are incurably lazy or inferior.

Finally, one of the chief advantages derived from the above effects of the system is, that it promotes a most friendly feeling between the men and their employers, and so renders labor unions and strikes unnecessary.

It is the opinion of the writer that the basis for harmonious co-operation lies in the two following facts:

1. *That the workmen in nearly every trade can and will materially increase their present output per day, providing they are assured of a permanent and larger return for their time than they have heretofore received.*

2. *That the employers can well afford to pay higher wages per piece even permanently, providing each man and machine in the establishment turns out a proportionately larger amount of work.*

The truth of the latter statement arises from the well-recognized fact that, in most lines of manufacture, the indirect expenses equal or exceed the wages paid directly to the workmen, and that these expenses remain approximately constant, whether the output of the establishment is great or small.

From this it follows that it is always cheaper to pay higher wages to the workmen when the output is proportionately increased; the dimin-

ution in the indirect portion of the cost per piece being greater than the increase in wages. Many manufacturers, in considering the cost of production, fail to realize the effect that the *volume of output has on the cost*. They lose sight of the fact that taxes, insurance, depreciation, rent, interest, salaries, office expenses, miscellaneous labor, sales expenses, and frequently the cost of power (which in the aggregate amount to as much as wages paid to workmen), remain about the same whether the output of the establishment is great or small.

The means which the writer has found to be by far the most effective in obtaining the maximum output of a shop, and which, so far as he can see, satisfies the legitimate requirements, both of the men and the management, is the *differential rate system of piece-work*.

This consists briefly in paying a higher price per piece, or per unit, or per job, if the work is done in the shortest possible time, and without imperfections, than is paid if the work takes a longer time or is imperfectly done.

To illustrate: Suppose 20 units or pieces to be the largest amount of work of a certain kind that can be done in a day. Under the differential rate system, if a workman finishes 20 pieces per day, and all of these pieces are perfect, he receives, say, 15 cents per piece, making his pay for the day $15 \times 20 =$ \$3. If, however, he works too slowly and turns out, say, only 19 pieces, then, instead of receiving 15 cents per piece he gets only 12 cents per piece, making his pay for the day $12 \times 19 =$ \$2.28, instead of \$3 per day.

If he succeeds in finishing 20 pieces, some of which are imperfect, then he should receive a still lower rate of pay, say, 10 cents or 5 cents per piece, according to circumstances, making his pay for the day \$2, or only \$1, instead of \$3.

It will be observed that this style of piece-work is directly the opposite of the ordinary plan. To make the difference between the two methods more clear; supposing, under the ordinary system of piece-work, that the workman has been turning out 16 pieces per day, and has received 15 cents per piece, then his day's wages would be $15 \times 16 =$ \$2.40 Through extra exertion he succeeds in increasing his output to 20 pieces per day, and thereby increases his pay to $15 \times 20 =$ \$3. The employer, under the old system, however, concludes that \$3 is too much for the man to earn per day, since other men are only getting from \$2.25 to \$2.50, and therefore cuts the price from 15 cents per piece to 12 cents, and the man finds himself working at a more rapid pace, and yet earning only the same old wages, $12 \times 20 =$ \$2.40 per day. What wonder that men do not care to repeat this performance many times?

As far as possible each man's work should be inspected and measured separately, and his pay and losses should depend upon his individual efforts alone. It is, of course, a necessity that much of the work of manufacturing—such, for instance, as running roll-trains, hammers, or paper machines—should be done by gangs of men who co-operate to turn out a common product, and that each gang of men should be paid a definite price for the work turned out, just as if they were a single man.

In the distribution of the earnings of a gang among its members, the percentage which each man receives should, however, depend not only upon the kind of work which each man performs, but upon the accuracy and energy with which he fills his position.

In this way the personal ambition of each of a gang of men may be given its proper scope.

Again, we find the differential rate acting as a most powerful lever to force each man in a gang of workmen to do his best; since if, through the carelessness or laziness of any one man, the gang fails to earn its high rate, the drone will surely be obliged by his companions to do his best the next time or else get out.

A great advantage of the differential rate system is that it quickly drives away all inferior workmen, and attracts the men best suited to the class of work to which it is applied; since none but really good men can work fast enough and accurately enough to earn the high rate; and the low rate should be made so small as to be unattractive even to an inferior man.

If for no other reason than it secures to an establishment a quick and active set of workmen, the differential rate is a valuable aid, since men are largely creatures of habit; and if the piece-workers of a place are forced to move quickly and work hard the day-workers soon get into the same way, and the whole shop takes on a more rapid pace.

The system of differential rates was first applied by the writer to a part of the work in the machine shop of the Midvale Steel Company, in 1884. Its effect in increasing and then maintaining the output of each machine to which it was applied was almost immediate, and so remarkable that it soon came into high favor, with both the men and the management. It was gradually applied to a great part of the work of the establishment, with the result, in combination with the rate-fixing department, of doubling and in many cases trebling the output, and at the same time increasing instead of diminishing the accuracy of the work.

In some cases it was applied by the rate-fixing department without an elementary analysis of the time required to do the work; simply offering a higher price per piece providing the maximum output before attained was increased to a given extent. Even this system met with success, although it is by no means correct, since there is no certainty that the reward is in just proportion to the efforts of the workmen.

In cases where large and expensive machines are used, such as paper machines, steam hammers, or rolling mills, in which a large output is dependent upon the severe manual labor as well as the skill of the workmen (while the chief cost of production lies in the expense of running the machines rather than in the wages paid), it has been found of great advantage to establish two or three differential rates, offering a higher and higher price per piece or per ton as the maximum possible output is approached.

The first case in which the differential system was applied furnishes a good illustration of what can be accomplished by it.

A standard steel forging, many thousands of which are used each year, had for several years been turned at the rate of from four to five per day under the ordinary system of piece-work, 50 cents per piece being the price paid for the work. After analyzing the job and determining the shortest time required to do each of the elementary operations of which it was composed, and summing up the total, the writer became convinced that it was possible to turn ten pieces per day. To finish the forgings at this rate, however, the machinists were obliged to work at their maximum pace from morning to night, and the lathes were run as fast as the tools would allow, and under a heavy feed.

It will be appreciated that this was a big day's work, both for the men and the machines, when it is understood that it involved removing, with a single 16-in. lathe, having two saddles, an average of more than 800 lbs. of steel chips in ten hours. In place of the 50-cent rate that they had been paid before, they were given 35 cents per piece when they turned them at the speed of 10 per day, and when they produced less than 10, they received only 25 cents per piece.

It took considerable trouble to induce the men to turn at this high speed, since they did not at first fully appreciate that it was the intention of the firm to allow them to earn permanently at the rate of \$3.50 per day. But from the day they first turned 10 pieces to the present time, a period of more than ten years, the men who understood their work have scarcely failed a single day to turn at this rate. Throughout that time, until the beginning of the recent fall in the scale of wages throughout the country, the rate was not cut.

During this whole period the competitors of the company never succeeded in averaging over half of this production per lathe, although they knew and even saw what was being done at Midvale. They, however, did not allow their men to earn over from \$2 to \$2.50 per day, and so never even approached the maximum output.

The following table will show the economy of paying high wages under the differential rate in doing the above job:

COST OF PRODUCTION PER LATHE PER DAY.

Ordinary System of Piece-work.		Differential Rate System.	
Man's wages	\$2.50	Man's wages	\$3.50
Machine cost	3.37	Machine cost	3.37
Total cost per day	\$5.87	Total cost per day	\$6.87
Five pieces produced.		Ten pieces produced.	
Cost per piece	\$1.17	Cost per piece	\$0.69

The above result was mostly, though not entirely, due to the differential rate. The superior system of managing all of the small details of the shop counted for considerable.

There has never been a strike by men working under differential rates, although these rates have been applied at the Midvale Steel Works for the past ten years; and the steel business has proved during this period the most fruitful field for labor organizations and strikes. And this notwithstanding the Midvale Company has never prevented its men from joining any labor organization. All of the best men in the company saw clearly that the success of a labor organization meant the lowering of their wages, in order that the inferior men might earn more, and, of course, could not be persuaded to join.

THE USE OF COMPRESSED AIR IN FOUNDRIES.

At a meeting of the Foundrymen's Association, recently held in Philadelphia, a paper on this subject was read by Howard A. Pedrick. In it he pointed out that compressed air could be advantageously used in foundries for a variety of purposes. The air supplied should be dry, so that in exhausting from a hoist or other apparatus it does not cause a spray. For this reason cooling the air by means of a water-jacket around the compressing cylinder is preferable to allowing water to get into the cylinder and mingle with the air. The air receiver or reservoir should be of liberal size—not less than 4 ft. in diameter and 8 ft. long, although, doubtless, the size must depend to a great extent on the amount of work done in a foundry. The receiver should be capable of standing a pressure of 100 lbs. per square inch, should have a gauge to indicate the pressure, a safety-valve, drain-cock at the bottom for drawing off water, and an inlet-hole not less than 1¼ in. diameter. The outlet should be near the top, where the air is dryest. The conducting-pipe through the foundry should not be less than 1¼ in., and every connection should be a T. If the openings thus left are not used they can be plugged up, and it will be found a good plan to arrange the pipe line so that a connection can be made without trouble or expense.

Wire-wrapped ¾-in. hose, which is quite good enough and not expensive, is the best conveyor of air from the pipe line to the different fixtures. A hose long enough to serve quite a floor area will do better, and save much time employed to do work in which now the moulder uses his hand-bellows and brush. These fixtures are similar to the common garden hose branch pipes fitted with a thumb cock on them, and are easily controlled, and are not liable to be lost and are a great convenience.

Pneumatic hoists may also be used with great advantage for handling materials, flasks, etc. Such hoists are now commercial articles, and cost very little.

The general construction is a cylinder fitted with a piston and rod suspended from the top end, allowing the piston-rod to have the load attached to it. They are direct-acting, needing considerable height of floor for working them. The general mode of using them is to hang them from a fixed position. This does well enough for certain work, but the better and most practical way is to have them arranged on a trolley running on an overhead rail. A jib-arm, arranged to cover a sufficient floor area, makes a fixture which can be handled and utilized with very little energy, at the same time more speedy than a mechanically moved apparatus for loads varying from 100 to 10,000 lbs.

Large travelling cranes are capable of being worked with compressed air as a motive power with very good results. The only change from the electric or power-driven machine is the driving of its engines with air. Hand-power travelling cranes can be easily made into power cranes, and accomplish much saving by the substitution of air power.

The pneumatic system of lifting seems to be better adapted for the general run of work, ranging from that which is too heavy for one man to handle up to about 10,000 lbs. The hoist requires no manual labor other than the manipulation of a small three-way valve. The speed for lifting is variable, being entirely under the control of the operator, the workman not having to wait for slowly moving mechanism or for the shop laborers to lend him aid, vastly assisting him in his work and removing any impediment to his entire independence.

The writer appreciated the delicacy required to lift a cope or flask from the drag without injuring the mould. For this particular purpose he described a taper-winding drum for the lifting chains to wind on, thereby reducing the speed of the lifting chains at the start, and also having the effect of lowering down to slacken speed as the terminus is reached. In parting a flask, it is good in practice to allow the chains to have considerable slack in it. The operator then admits enough air to slowly start the winding drums, which, when the hoist encounters the frictional resistance offered, appear for an instant to cease lifting. Here it is that the elasticity of air plays its part, for after the apparent stop the hoist will gently strain on the chains until the power is enough to overcome the resistance, lifting the cope without damage to the mould, which can then be handled as rapidly as desired.

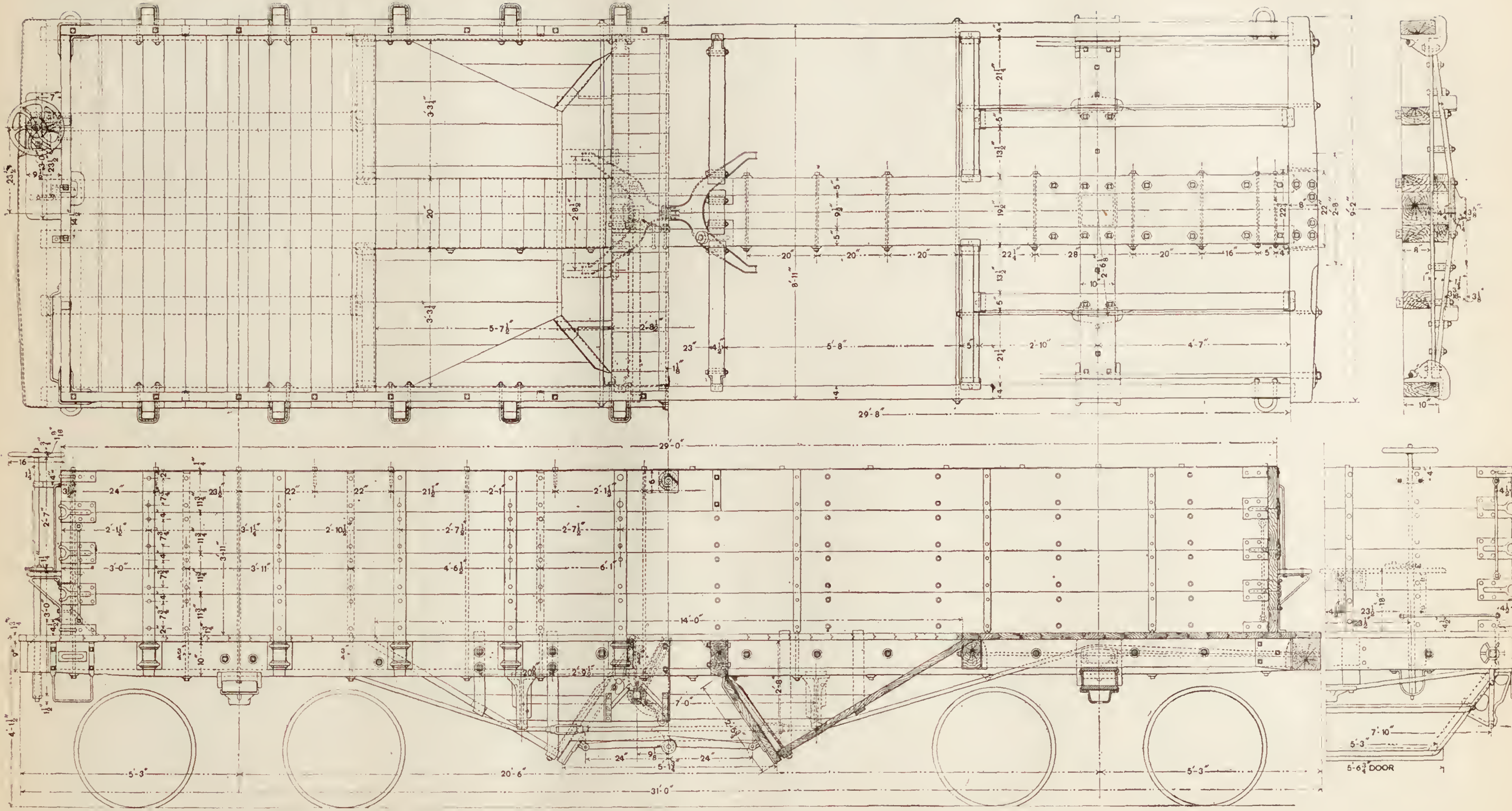
Those who use the foundry's product appreciate well-cleaned and good-looking castings, and are disposed to patronize a foundry looking well after this end of the business. Often they are willing to pay a higher price where attention is given to this point. Some few years ago the experiment of cleaning castings by the sand blast process was tried, and some difficulties were encountered that caused it to fall short of the expectations of some of the experimenters. Steam at about 60 lbs. pressure was the force then used. It wet the sand, causing frequent clogging of the pipes, and made it next to impossible for a man to stand the severe rebound of the sand; but realizing the future the sand blast had before it, its promoters have perfected the apparatus by the use of compressed air. This now allows its use for bringing castings to a further degree of perfection, removing scale, and cleaning off in a thorough manner all the burnt-on sand in places which otherwise would be hard to reach. Ornamental and fancy castings can be thoroughly and cheaply treated in this way, producing an article which otherwise requires considerable labor to finish. In ordinary classes of work it is possible, and at the same time practical, to clean thoroughly 6 sq. ft. per minute, no matter how much ornamentation covers the casting. Steel castings are very hard to clean ordinarily, but yield under the influence of the sand blast. The machine used for supplying the sand is constructed in appearance like a vertical boiler, fitted with the necessary mechanism of feed-valves, sand chambers, etc., so arranged that an air pressure of about 10 lbs. per square inch catches the sand and delivers it through a pure rubber hose, which on moving about must not kink. A sharp bend would allow the sand, going at the velocity it does, to soon destroy the hose. A peculiar feature of the sand blast is that it only cares to attack hard substances. Anything of a soft or yielding nature will stand to a remarkable degree its cutting action. In practical operation the work is accomplished by handling the hose pointed at the object in the same manner as if playing water on it. In operation it creates considerable dust; to prevent this an open or well-ventilated place is preferable, as the dust then cannot become obnoxious. The machine is portable, and by conveying the air supply to it allows it to be used almost anywhere. The application of the sand blast does not find its full utility for foundry work in just the foregoing procedure. The writer's attention was called a short time ago to an ingenious contrivance in the nature of a tumbler or a rattler, revolving on frictionless rollers, with an attachment for the sand-blast nozzle. The action of the machine was the same as of that now used in the average foundry, except in having the sand blast applied to it, which appeared to possess much merit in more thoroughly cleaning the smaller pieces with less tumbling.

The pneumatic chisel will do vastly more and better work than several men can accomplish in the old way. This little tool will weigh about 15 or 20 lbs. It is a cylindrical piece of steel bored out to receive the piston, which is also the hammer. A small valve controlled by the air pressure admits air on either end of the piston, causing it to reciprocate very rapidly and to strike a blow at every stroke. The chisel is placed on a shank projecting from the cylinder. The tool is then placed against the particle to be removed. A slight pressure of the hand holding the upper end of the tool admits air, which starts the hammer. Externally there is nothing moving, the chisel is kept in contact with the work, as if the operation were a pushing-off process. The amount of work accomplished by this little air tool is surprising, and where much hand chipping is done, opens a way of very materially reducing the cost and labor for such work.

Again, in foundry practice it sometimes happens that large, heavy castings must be broken up to be returned to the cupola, and a small portable drill, with compressed air for the motive power, will allow several holes to be drilled into such a piece, after which a round taper steel wedge with a few well-directed hammer blows will sever the piece; it will then be suitable to be handled for remelting. This little machine has sufficient power to readily drill a ½ in. hole, and weighs about 40 lbs. Its size and weight allows it to be used in almost any place where the air-hose can be attached to it.

In almost all lines of manufacturing there are often disagreeable operations to perform, and probably one of them is the breaking of pig iron. This is not only a hard, laborious task, but one that a man does not care to stick at for any length of time. This can all be changed where air pressure is available. The machine is quite simple in construction, being a cylinder fastened to an upright piece with a weight attached to the piston-rod, with a hollow anvil block at the bottom. The pig bar is then placed on this block. A lever which controls the valve admits air under the piston, raising a 300 or 400-lb. weight; then, by a reverse movement of the lever, the air is quickly exhausted, down comes the weight, breaking the iron in the middle. Each end is again placed under the hammer, and one blow generally has the desired effect, saving much time aside from saving disagreeable labor.

The idea of having portable sand-shifting machines has many advantages over the belt-driven machines, which are located in a fixed position and sand conveyed to and from them. The sand sifter fixed with the necessary mechanism for compressed air can be moved from place to place to perform its work, which results in the saving of time usually re-



KING'S DOUBLE HOPPER-BOTTOM GONDOLA CAR OF 60,000 LBS. CAPACITY, BUILT FOR THE LEHIGH VALLEY RAILROAD.

quired to convey many tons of sand to and fro. The machine is not unlike the ordinary power or belt-driven kind. The change is in having the air do just the service performed by the belt. Wire-wrapped hose is the conducting pipe.

Compressed air certainly has a wide field of usefulness, and can accomplish much in the foundry with a decided saving resulting. The plant is not necessarily expensive to inaugurate or maintain. The average foundry, with a plant costing from $800 to $1,500, can make a good showing. The writer would only suggest that once this labor-saving element is introduced in the foundry and elsewhere, many additional applications will continually suggest themselves to the ingenuity of the progressive operator.

HOPPER GONDOLA CAR, LEHIGH VALLEY RAILROAD.

The Lehigh Valley Railroad Company placed an order some time ago for a large number of hopper-bottom gondola cars, to be used in their eoal service, which embodied in their construction and design the best practice that has resulted from the long experience with eoal cars upon this road. The cars are equipped with the Fox trucks, the Westinghouse automatic air brake of the latest design, and the national hollow brake beam. The Gould M. C. B. yoke eoupler is used, together with the Schoen draw-bar side lugs.

In the construction of the double hopper, the King arrangement for closing the doors is used. It will be seen from an examination of the side elevation and section of the car published on page 358, that there are two hoppers sloping down toward the eentre from a cross-sill just above the inner truck wheel, leaving about 7 ft. of floor to be cleared by shovelling. The doors swing inwardly toward the centre, and are held out in a closed position by a yoke acting as a knee joint that is held down in the elosed position by the set of crank arms and levers shown in the side elevation, the shape of the joint being clearly shown in the plan. Thus the two doors braee against each other, and no extra strain is thrown upon the fastenings by the weight of the coal, while the doors are readily dropped by a eomparatively light pressure.

The trucks are shown in great detail by the engravings, upon which the dimensions are very fully given, so that an examination of the same will give a better idea of the truck than an extended description.

It will be seen from the plan that the centre sills extend the whole length of the car. The centre and intermediate sills are of yellow pine 5 in. × 8 in., and the outside sills are of the same material, but 10 in. deep. The cross sills at the trucks are 5 in. × 8 in., of oak, and those at the centre, upon which the doors are hung, are 4½ in. × 10 in.

It will be noticed that the high sides of these cars are strengthened by a cross bolt protected by an angle iron, as recommended by the M. C. B. committee on this subject and reported in our last issue.

The body bolster is of the regular type used on the Lehigh Valley rolling stock. The ends are turned down and welded, as described in the AMERICAN ENGINEER for November, 1894. In the construetion, white oak is used for end sills, draft timbers, stakes, all blocking for draft timbers, flooring, doors and chute planking.

The body is braced by two 1½-in. truss rods that are upset to 1⅝ in. at the ends, and which pass over a truss post over the body bolster that is cast solid with the step to which that bolster is bolted.

While it is impossible to say that this or any other car represents a distinet departure from current practice, it may still be regarded as a type of the most approved construetion for this elass of car at the present time.

The principal dimensions of the car are as follows:

Length over end sills	31 ft.
" inside end planking	28 ft. 6½ in.
Width over side sills	8 ft. 11 in.
" inside side planking	8 ft. 5½ in.
Height top of sills to top of planking	4 ft. ¾ in.
Distance between centres of car bolsters	20 ft. 6 in.
Size of hopper opening	50 sq. ft.
Truck-wheel base	5 ft 2 in.

TUBULOUS BOILERS IN THE FRENCH NAVY.

ASSISTANT ENGINEER JOHN K. ROBINSON, U.S.N., has contributed an article to the *Journal of the American Society of Naval Engineers*, in which he gives the results of his observations on the working of water-tube boilers on French ships, and in which he says:

"There are only three types which can be said to have any chance of replacing the Scotch boiler: the Belleville, the D'Allest, and the Niclausse. Other types essay to fill the places of these boilers, but, so far as I know, the three named are the only types that are used in vessels larger than gunboats. Others have been tried with a view to applying them in large vessels, but so far they have not been a success.

"Of the boilers mentioned, the Belleville is the oldest type; it is claimed for it that it is also the oldest tubular boiler, and it probably is the oldest French one. It is too well known to require description, but some eonsideration of its working may not be out of place, when it is considered that the results are those reached where the experience has been greater than ours

"The extremely small quantity of water in the boiler has made the use of an automatic feed-regulator necessary. This regulator works well when it does work, but fails to work at all often enough to destroy all confidence in it. Besides, when the regulator fails to work serious aeeidents often result. The amount of feed-water is so small that any failure of the regulator to act is liable to cause the water to disappear entirely from the boiler. The small quantity of water in the boiler likewise eauses large variations in the steam pressure, and necessitates a larger pressure in the boiler than at the engines—that is to say, there is a reducing-valve between the boilers and the engines.

"The slow circulation of the water causes the tubes to deteriorate very rapidly if the water is not pure. The tubes of the lowest row are made very thiek, but they wear out very rapidly nevertheless, being bent after fires are lighted under the boilers two or three times.

"The system of circulation of the water causes a great deal of 'priming,' and this cannot be cured even with the use of a eomplicated set of baffle plates in the steam drum of the boiler, and with the addition of a separator between the boilers and the reducing-valve. The reducing-valve must also reduce the amount of water in the steam, though, as has been seen, this is not the prime object of its use. It has been estimated by engineers that have worked these boilers for several years, that the amount of water in the steam at the cylinders is never less than 10 per eent.

"The use of the Belleville boilers was said at the outset to be sure to give a great gain in eeonomy of fuel. In fact, many engineers still seem to think that they are not greatly inferior to the Seotch boilers in this respect. The fact is, however, that the arrangement for the eombustion of the eoal to take place entirely in one plaee has made the mixing of gases of combustion very poor. To insure proper mixing all the gas from the grate should be brought together at some point before the combustion is supposed to be completed. This would correct the inequalities in the thickness of the fires in different parts of the grate. So very poor is the mixing of gases in the Belleville boiler, that it has been found necessary to have a pump for foreing jets of compressed air in the top of the furnaee, foreing the gases of eombustion down toward the grate, and so promoting their thorough mixing.

"The absolute necessity of a sure-aeting feed-pump has led to the use of a specially designed pump that will always be sure to act. This result is obtained at the cost of a large amount of steam for the pumps, but the result is so necessary that it has been said that the pump is what makes the boilers.

"The accessories to this boiler are so numerous that they make a considerable addition to the machinery of a vessel. The number of separate machines that are required to make this boiler act in at all a safe way leads to an exaggerated amount of repairs, and the care of the steam-producing plant becomes a more diffieult matter than that of the engines. The repairs to the boilers are more costly than those for ordinary boilers. Not that any one ease of repairs is not eheaper than a similar job would be with Scotch boilers, but the greater number of repairs has led to greater expenses for the government in the repair shops. The repairs can, however, be made in a mueh shorter time than with the cylindrieal boilers, and this must be held to counterbalanee in a large degree the greater frequency of break-downs in the boilers. Also the large number of boilers in the steam-producing plant of a powerful ship makes the loss due to the putting out of commission of any one boiler a minimum. It is also to be noted that all ships that are fitted with these boilers have more boilers than are necessary to the running of the engines at full power. Thus it is always possible to run at full power even with one or more boilers disabled.

"The advantages of the Belleville boiler over the Scotch boiler that are the most appreciated in France, are the great gain on the weight of the steam-producing plant, even with a reduction in the forcing of the boilers and the ease of raising steam. The pressure allowed for this boiler is practically unlimited by the boiler, on account of the small diameter of the cylinders that contain the steam. The parts are small and

can easily be removed from the boiler-rooms without cutting any holes in the decks. In fact, the whole boiler may be removed from the boiler-room without troubling the decks at all.

"The manufacturers of this boiler claim that it is possible to use salt water in it without any bad effects. Though it has never been intended that they, more than any other working at a high pressure, should be usually fed with salt water, it has been occasionally necessary to use salt water in them. The results have not been of the best. The tubes were found to be eaten away, and the rods of the feed regulator were soon covered with incrustations that prevented it from acting, and so entirely destroyed the boiler.

"As has been said, these were the first French tubulous boilers. While Mr. Belleville has been constantly at work devising methods of making his boiler run with success, other people have been busy devising some way of getting around the difficulties in the Belleville boilers by a change in the system. . . .

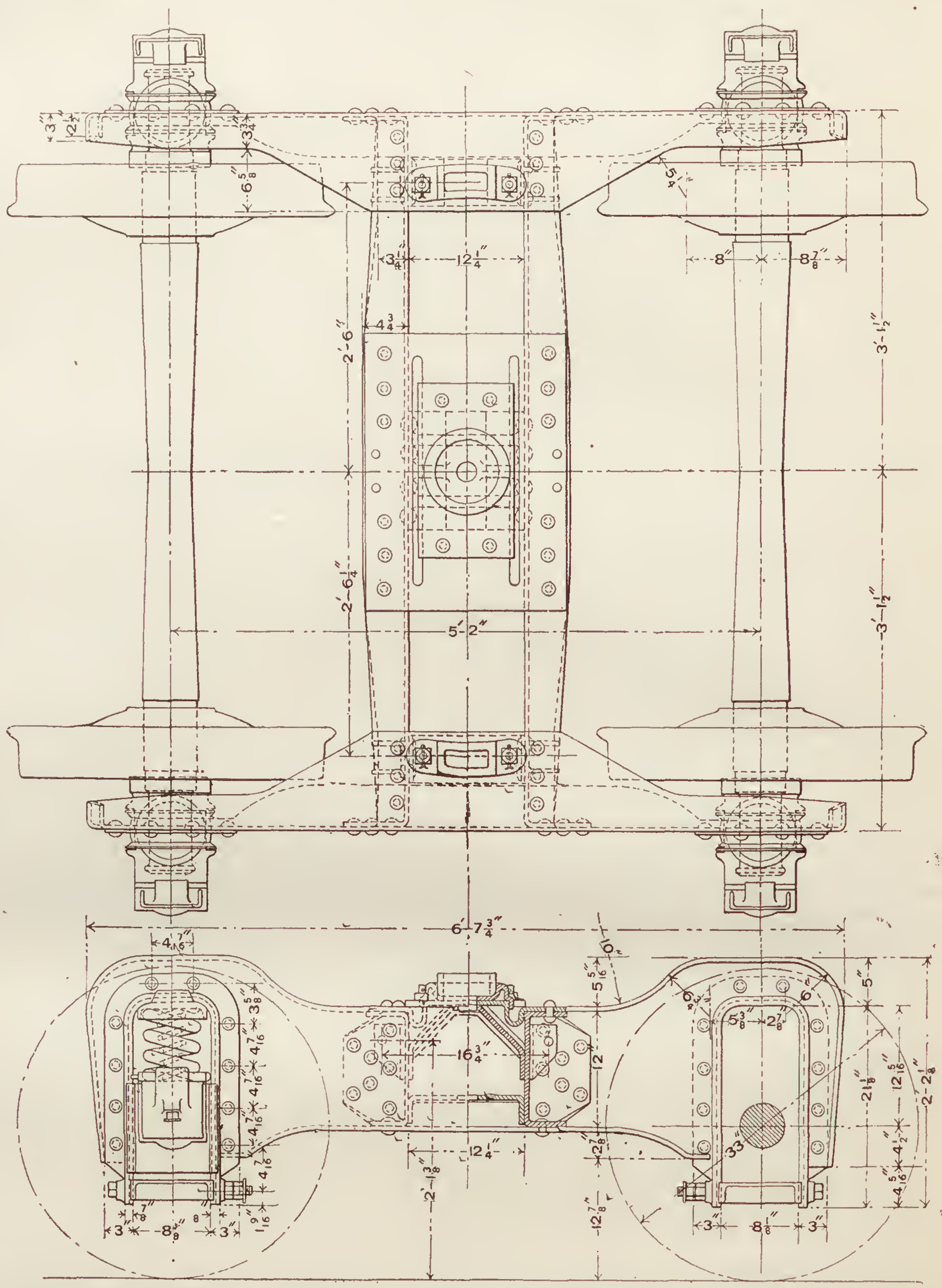
THE BELLEVILLE BOILERS OF THE "AUSTRALIEN."

"The Messageries Maritimes is one of the greatest steamship companies of France, if not the very greatest. This company began the use of Belleville boilers some five or six years ago. The officials of the company seem to be fairly well satisfied with the performance of them, but there is a tendency to obtain something that will give better economical results. Designs were prepared in the last vessel designed (the *Ernest Simon*) for the use of Scotch boilers. There was still a question as to which type of boilers would be adopted when I left France. . . .

"The watch for four hours consists of one engineer, two chief firemen, three first-class firemen, two Arab leading men of the fire-room, eight Arab firemen, six Arab coal-passers, two European oilers, two Arab oilers; total, 26 men. . . .

"There is always danger of tubes giving way with the use of salt water, and the boiler is then of no use until the tube is replaced. This is of little danger in any other way, as the breaking of a tube is dangerous to those in the fire-room only if the furnace-door is opened by the first shock. After that there is no danger of the steam entering the fire-room. The average life of the tubes is from two to three years. The causes of burning are the failing of feed, or the internal corrosion in the tubes, which is the result of use in whatever conditions.

"The feed regulator is liable to fail in use. The wire test placed on each regulator is used as often as possible, say every hour. Nevertheless, the regulators are apt to give trouble by "going to sleep." This may be caused by the formation of deposits on the regulator rods, or on the valve itself. Even dust on the outside of the regulator, on the moving parts, is liable to cause it to fail to act. As one of the engineers on the *Australien* said: 'A regulator may not fail for four hours, but then again three or four of them may fail in that time.' All the water levels are protected, and fully as much attention is paid to them as with the ordinary boilers, but frequently the regulator will fail, and the drop in the water of the boiler will not be noticed till too late. The great trouble with the regulator is that when the water is lowest the effort on the regulator is the greatest, and several times they have opened after the water had entirely disappeared from the boiler, and even when the boiler was red-hot. In that case it is clear something had to break. It was always a tube or tubes. In one case tubes of every element in a boiler burned out at the same time, and due to the above cause. This failure of the feed, due to a failure of the automatic feed, is the cause of most of the accidents to the boiler. The engineers of the Messageries Maritimes have tried to do without the regulators, but have not succeeded in regulating the water well enough in this way to run them without a man on each boiler with that for his duty and nothing else. As soon



PLAN, SIDE ELEVATION, AND SECTION OF THE FOX PRESSED STEEL TRUCK, USED ON THE DOUBLE HOPPER-BOTTOM GONDOLA CARS, LEHIGH VALLEY RAILROAD.

as the regulator is found to have failed, which will generally be discovered when a tube bursts, the fires are drawn from that boiler. It requires about ten minutes to empty a boiler and to burn out a tube after the regulator fails. . . .

"As summed up by one of the ship's engineers :

"'The great advantage of these boilers is the ease with which they can be repaired. A tube can be replaced in two hours, and this is the most frequent accident to the boilers. The tubes are the weakest part.

"'The Belleville feed-pump is what makes the boiler. It is perfect.

"'The ejector is good for what it is intended. With fresh feed-water, even without a filter (which would be a great improvement), and by adding lime to the feed all the time, there is no danger from any deposits in the tubes. There will always be some deposits in the tubes, but nothing to speak of.

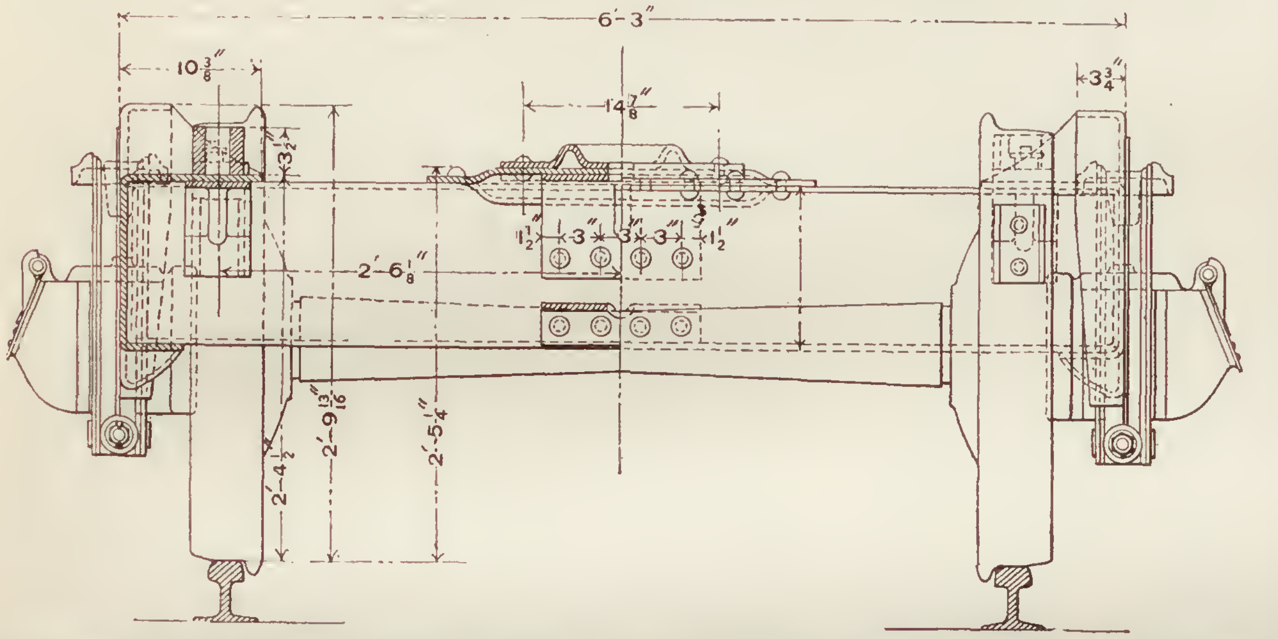
"'The reducing-valve is very good, and always works well.

"'It is rare that there is sufficient priming to interfere with the working of the engines, although it is always considerable.

"'It is not possible to keep up the water level by hand, except by using a man for each boiler for this purpose. The great trouble comes from the use of even a small quantity of salt water in the boilers. The regulator is soon clogged up and does not work, and then firing must be stopped. Yet some feed regulator is indispensable.

"'The firing is difficult. An ordinary fireman can never succeed here.

"'The Belleville boilers are much less economical than the ordinary ones, and the cost of making repairs to them is greater than for Scotch boilers. Besides this their first cost is greater.



END ELEVATION OF FOX PRESSED STEEL TRUCK FOR DOUBLE HOPPER-BOTTOM GONDOLA CARS, LEHIGH VALLEY RAILROAD.

"'Great care has to be exercised with all these delicate machines, and you can never tell what will be the next thing to break down.

"'If you want Belleville boilers, you must have engineers everywhere.

"'It seems to me that there is no doubt that the ordinary (Scotch) boilers are the boilers to have, and that there is no use of bothering one's self with all this machinery.

"'If the regulator sticks, the boiler must be put out of use.

"'The automatic separator trap is not satisfactory, and is always worked by hand.'

"An attachment has been fitted permitting the fires to be drowned with water while on the grates.

"The Belleville boilers show a saving in weight over Scotch boilers about equal to the weight of the water in the latter, and a saving in space of about 7 per cent. This saving in space varies according to the ship from zero to 10 per cent.

"The ratio between the heating and the grate surfaces is about 30.

"The cost of running the engines of the *Australien* during the year 1893 was 2.30 lbs. per I.H.P.

"The estimates for this ship called for a speed of 19 knots on the trials (17.52 realized), and for 17 knots in ordinary running (14.60 realized). The cost of the power was set at 1 54 lbs. per I.H.P. It is evident that these boilers have not been remarkable in their economy.

"On the ships of this line which use Scotch boilers, and those of an old type with pressures of 90 and 100 lbs. with old compound engines, the cost of a H.P. during the year 1893 was 2.02 lbs. per hour. If the use of triple-expansion engines gives an economy of 20 per cent., the cost of the Belleville boilers in coal alone exceeds that of Scotch boilers by 42 per cent.

"If the *Australien* had been fitted with Scotch boilers, she could have made a trip to Australia with a less weight of coal and machinery than with the present boilers. The question of cost, it will be remembered, has not been touched upon.

BELLEVILLE BOILERS IN THE FRENCH NAVY.

"Nearly one half of the vessels now being constructed for the French Navy are to be fitted with Belleville boilers. Those now in use have given fair satisfaction. . . .

"The lack of economy of these boilers has been condemned in the Navy as in the merchant marine. On the trials of the *Brennus*, a battleship fitted with Belleville boilers, and the largest ship, in point of power at least, to be fitted with them, the results of the preliminary trials were most unsatisfactory. The coal per I.H.P. was 3.95 lbs. on one trial ; and later, when the firemen had become more accustomed to the boilers, this figure was reduced to about 2.45 lbs. This is at the most economical rate of speed for the ship. In calculating the consumption of the engines, there is an auxiliary boiler that supplies all the auxiliary machinery except the air and circulating pumps, and the power of the main engines is used for the calculations. The power of the feed-pumps is neglected, and acts as a loss for the boiler furnishers. Neither of these trials was long enough to necessitate the fires being cleaned. . . .

THE D'ALLEST BOILER.

"The D'Allest boilers are not quite so heavy as the Belleville, but the floor space occupied is greater for the same area of grate or heating surface. As, however, the D'Allest boilers are much more capable of being forced than the Belleville (which are uneconomical with over 15 lbs. of coal burned per square foot of grate), it may be said that the space occupied by the D'Allest boilers is not greater for the same power than that required by the Belleville. A great advantage for the D'Allest boilers is, that with them it is unnecessary to have more than the ordinary auxiliaries of the Scotch boilers, and the frequency of repairs with the Belleville boilers is thus avoided. The amount of water in the D'Allest boilers is not, of course, so great as in Scotch boilers, but it is sufficient to make the use of that bugbear of the practical engineer, the automatic feed regulator, unnecessary. The cost of running the D'Allest boiler is far less than that of the Belleville, and, indeed, it may be said that on this point the D'Allest boiler may be compared with the Scotch. It has an independent combustion chamber, and thus the gases are well mixed before entering the uptake. The results of steaming with this boiler are in marked contrast with those from the use of the Belleville. While the D'Allest boilers have not required more coal than Scotch boilers for similar engines, the loss in coal has been with the Belleville boilers as much as 42 per cent., as will be seen later.

"The greatest advantage of the Belleville boilers over the D'Allest lies in the comparative freedom of the tubes of the Belleville boiler to expand when heated, they being fastened at only two points in each element, while those of the D'Allest are fastened, the same as the tubes of Scotch boilers, at both ends of each tube. This reduces the danger of leaky tubes in the Belleville below what it is in the D'Allest boilers. Another advantage of the Belleville over the D'Allest lies in the fact that the parts of the former are smaller than those of the latter, and that, therefore, there is less difficulty in removing them from the fire-rooms in case of injury beyond repair. When one considers the fact that the French Government requires reducing-valves to be placed between the boilers and the engines whenever tubulous boilers of any type whatever are used, some excuse for the use of the Belleville in preference to the D'Allest boiler may be found. Of course, the question of the advisability of using any type of tubulous

boilers is quite apart from the question of the superiority of one tubulous boiler over another.

THE NICLAUSSE BOILER.

"Of the many other types that have been proposed for replacing the Scotch boilers, there is but one—the Niclausse—that has so far been recognized as possessing the points that are requisite for use in men-of-war. These boilers are modifications of the Collet. The differences between the new boiler and the older one lie almost entirely in the details of construction, the main points of the boilers being the same. These boilers are as different from the others as the latter are from each other. They are compared only with the D'Allest, as the latter are so evidently superior to the Belleville that it would be waste of time to include a second comparison.

"The weights of the D'Allest and the Niclausse boilers are practically the same for the same area of heating surface, with the same advantage for the Niclausse in regard to the space occupied as for the Belleville boiler. But while the Niclausse boilers are capable of being forced more nearly to the power of the D'Allest than the Belleville boilers are, they are not the equals of the D'Allest in their capacity for high powers. It may, therefore, again be said that the D'Allest boiler takes up less space for the same power than the Niclausse. Both of these boilers give dry steam at the highest powers at which they are run, and, therefore, have a point of advantage over the Belleville. The amount of water in the Niclausse is less than in the D'Allest, but it is still large enough, so that the water level may be easily maintained without the use of any other than the ordinary check-valves on the boilers. The greater the amount of water in any boiler, however, the better it is for keeping a steady steam pressure; and some difficulty was experienced in maintaining the pressure of steam constant during the forced draft trials of the *Friant* (fitted with Niclausse boilers). The frequency of repairs to one of these boilers is about the same as for the other, and the cost is about the same in each case. The joints in the Niclausse boiler are all metallic and conical, and so require more care in the making, but are less liable to give trouble when once made. The tubes are all free at one end, and therefore the danger of leaky tubes is reduced to a minimum. In fact, during all the trials of the *Friant* there were no leaks in this boiler. It is another point in its favor that the repairs are all made from the front of the boiler. It must also be remarked that it is easier to mount and dismount a tube in the Niclausse than in any other type of tubulous or other boiler. The complete operation of removing a tube and replacing it with another took, in one instance, within my observation, less than two minutes.

"The advantages that the D'Allest boilers have are chiefly in the matter of economy. As has been said, they are about as good as the Scotch boilers, while the Niclausse or the Belleville give much poorer results in actual use than have been found from the use of ordinary boilers. Another advantage of the D'Allest boiler lies in the fact that the tubes in the rows next to the fires are all Servé tubes, and thus much less liable to burn out than ordinary tubes. It would be hard to use this type of tubes in the Niclausse boilers, on account of the inner circulating tube in each element. It would seem that tubes of the type used in the Niclausse boiler are the best, however, on account of their freedom to expand when the boiler is being fired. The one great advantage of the D'Allest boilers seems to lie in their great relative economy over any other tubulous boilers. Mr. D'Allest himself says that this advantage is almost if not entirely due to the use of an independent combustion chamber. There would be little difficulty in adding a combustion chamber to the Niclausse boiler, and then it would seem that this boiler would be inferior to the D'Allest in but the detail of the amount of water in the boiler. This defect could be remedied by a change in the size of the tubes to allow for the increased rate of evaporation rendered possible by the addition of the combustion chamber, and by the use of a larger steam drum at the top of the boiler. Perhaps even now it may be said to be a question whether the Niclausse boilers are not the equals of the D'Allest, but the opinion of the French engineer seems to be that the D'Allest are the boilers of the future, and that, with a few changes, they can be readily supplied in the place of the Scotch boilers. The addition of hydrokineters would reduce the disadvantages of the D'Allest tubes being fixed at both ends. This apparatus has not yet been used in these boilers.

"In the use of these boilers in the French Navy it is to be remarked that even with the number of spare boilers (20 per cent. in many cases), and with the small rate of combustion allowed in all cases (never above 31 lbs. of coal per square foot of grate), and with engines that are considerably heavier than those used for the same power in this country, the total weight of the machinery is not so great as in our latest ships. In no case of a modern French man-of-war fitted with tubulous boilers that I now recollect has the weight been over 200 lbs. per I.H.P. of all the machinery; in most cases the weight is down to about 185 lbs. These figures are, of course, for large vessels of the battleship or fast cruiser type. This seems to be the greatest if not the only advantage for the tubulous boilers. The pseudo advantage of quickness in raising steam is one that is more than counterbalanced by the always attendant greater difficulty in managing the boilers when under pressure.

"The pertinent points that seem to me to need attention in the French boilers are that the tubes are always so arranged as to be easily removed or cleaned. This seems to be an absolute requisite for any boiler that can entirely replace the Scotch boilers.

"Tubulous boilers will always give more trouble to keep in good condition than would Scotch boilers, but they are sure to retain their full efficiency almost indefinitely, as the worn parts are replaced by new ones that are as strong as the old ones were in the first place. There is no shell to deteriorate.

"It is also to be remarked that the tubes used in these boilers are invariably of a larger diameter than is generally used in the boilers made in this country. The gain in the weight of the boilers may be said to be about equal to the weight of the water in Scotch boilers that would have to be substituted for the tubulous boilers."

THE ECONOMY OF STEAM-JACKETS AND SUPERHEATED STEAM.

In a lecture on The Development of the Experimental Study of Heat Engines, delivered in London recently, Professor Unwin said:

"Some time ago I ventured to say that there was no trustworthy engine test which showed that the consumption of steam with a jacket is greater than without the jacket. I believe that is still true, but undoubtedly the economy due to the jacket varies in different cases from 30 per cent. to very nearly zero. Roughly, the jacket is more useful with small engines than with large, with slow engines than with fast engines, but all this amounts to little more than saying that the jacket is most useful in those cases where the initial condensation is largest. Just in proportion as the engine, whatever its type, is of the highest class and most scientific design, the jacket is less useful. No one probably designed better simple engines than Corliss, and Corliss did not use jackets. In an experiment by Delafond on a large Corliss engine at Creusot, the jacket effected an economy of only 2 per cent. The same rule holds with compound engines. Hirn found an economy of 25 per cent. due to the jackets, in a Woolf engine tested in 1855, but since then the compound engine has been improved, and the advantage of the jacket is less. Professor Witz made very accurate experiments with a large compound engine of about 600 I.H.P., provided with jackets both to cylinders and receiver. The trials were strictly comparable, the pressures, temperature ranges, and total power developed being nearly the same. The total condensation in the jackets was 12 per cent. of the steam used, so that the jackets were not inactive. Yet the absolute saving of steam due to the jackets was only 4 per cent., or allowing for heat saved by returning the jacket drainage to the boilers, 6.6 per cent. It is perhaps probable that as the temperature range in the cylinder is diminished by compounding, the temperature gradient from the jacket to the interior of the cylinder is diminished and the rate of transmission of heat decreased. It appears, then, that as engines are better designed, the jacket is of less use, and it is not by means of the jacket that the waste due to cylinder condensation can be got rid of, or the highest economy of which the steam-engine is capable reached. The jacket reduces, but it does not prevent initial condensation.

"Hirn looked for some more powerful way of heating the cylinder wall without causing condensation; he found it in superheating. He constructed in 1855 a superheating apparatus in the flues of the boiler at Logelbach, which still exists. The experiments with superheated steam were carried out between 1855 and 1856, and showed clearly the effectiveness of the method in reducing condensation. Superheating came largely into use in the years 1860–70 in this country in marine engineering practice, having been introduced here by John Penn. In every case in which it was used an economy of coal was realized. Generally, the economy amounted to from 15 per cent. to 20 per cent. It was ascertained that this was due strictly to economy of steam, and not to the utilization in the boiler of heat previously wasted. But the use of superheated steam in this country was gradually abandoned, partly, no

doubt, from some practical difficulties, but chiefly, I believe, because practical engineers had no clear idea why superheating should produce so large an economy, and they were not indisposed to abandon a complication the action of which they could not satisfactorily explain to themselves.

"In Alsace superheating has never been entirely abandoned, and during the last ten years hundreds of boilers have been supplied with superheaters. So far as I can ascertain, no difficulty arises in using steam superheated to 500° F., and in good and large engines the steam consumption is reduced when the superheating amounts to 100° by 15 per cent. on the average. I have no doubt myself that superheating will be largely used again. The practical difficulties exist, but they are not insuperable. No possible improvement of the steam-engine of which we have any knowledge at this moment offers anything like so great a chance of important economy as the re-introduction of superheating, and especially of superheating to at least 100°, or more above the saturation temperature of the steam. I obtained in Alsace, on a very good 500-H.P. compound mill engine, with jackets and every appliance for economical working, an economy of 15 per cent. Mr. Mair Rumley has fitted a superheater to a Babcock boiler supplying a triple engine, and has obtained an economy of 10 per cent. In both cases the economy is economy of steam, and therefore is not due to any increase of boiler surface, or increase of efficiency in generating the steam. Lately Professor Schroter, of Munich, has been experimenting with a small special compound condensing engine of only 60 I.H.P., running at the moderate piston speed of 380 ft. per minute, and with the not excessive boiler pressure of 165 lbs. per square inch. The high-pressure cylinder is not jacketed. The low-pressure is jacketed with receiver steam. In this case, in a tube superheater of a rather special construction in the uptake of the boiler, the steam is superheated to 670° F., or nearly 300° above the saturation temperature corresponding to the pressure. In two trials of six and eight hours' duration—periods quite long enough for accurate determination of results with so accomplished an observer as Professor Schroter—the consumption of steam was only 10.2 lbs. per I.H.P. hour, and the consumption of German coal of moderate quality only 1¼ lb. per I.H.P. hour. The steam consumption is the lowest on record for any engine of any type or size, and is very remarkable for so small an engine. It is often argued that, as very little heat is required to superheat steam, it cannot produce much effect. The answer is, that a small amount of heat rightly applied in preventing initial condensation produces a disproportionately large effect. That is consistent with the strictest principles of thermodynamics. In the Schmidt engine only 8 per cent. of the heat was used in superheating the steam, and to this 8 per cent. the remarkable economy is due. In a steam-jacket acting well about 12 per cent. of the steam used is condensed, and to this 12 per cent. the advantage of the jacket—which often reduces the amount of steam used in the cylinder by 20 to 30 per cent.—is due. But the heat from a jacket is much less efficiently applied than the heat taken direct to the interior of the cylinder by superheated steam, and used primarily in maintaining the temperature of the admission surface. Further, the quantity of superheat brought into the cylinder in a given time increases with the speed of the engine, while jacket heat diminishes in effect as the speed is greater. The action of the superheated steam is shown clearly enough on the indicator diagrams. In my own trials in Alsace, the wetness of the steam at cut-off in the high-pressure cylinder with jacket—but without superheating—was 35 per cent.; with steam superheated 100° it was only 15 per cent. In the trial with the Schmidt engine there was no moisture at cut off in the high-pressure cylinder, and the steam remained dry till nearly the end of the stroke."

THIRD-CLASS TORPEDO-BOAT FOR THE UNITED STATES CRUISER "MAINE."

In our issue for October, 1894, we illustrated what are undoubtedly the lightest quadruple-expansion engines that have ever been built for the H.P. developed. They were intended for use on the third-class torpedo-boats to be carried on the deck of the cruiser *Maine*, and are now in position. The engraving on page 364 is a reproduction from a photograph of one of these vessels, while the general details of the construction are clearly given on page 365.

Considerable interest cannot fail to be taken in the performance of these boats that will form a portion of the equipment of the *Maine* and the *Texas*, for the latter vessel is also to be provided with them.

The boats are to form a part of the complement of boats for the above-mentioned vessels.

Their function will be to operate from the vessels as a base, hence a small supply of coal. One ton for *Maine's* boats and three-quarters of a ton for *Texas'* boats is allowed, and the boats are made exceedingly light so that they can be readily hoisted on board, the hull and fittings weighing only 13,785 lbs. for the *Maine* and 10,992 lbs. for the *Texas*.

Boats of this class have been furnished to vessels of foreign navies, but up to the present time have never been supplied to vessels of the United States Navy.

The design for hull and fittings was prepared by the Bureau of Construction and Repair of the Navy Department, and the machinery by the Bureau of Steam Engineering.

The two boats for the *Maine* will each be fitted with a bow tube for discharge of an 18-in. Whitehead torpedo, and the two boats for the *Texas*, being smaller, will each be fitted with a deck-training tube for a torpedo of the same type and size.

The frames of the boats vary in size from 1¼ in. × 1¼ in. of 1.5 lbs. per foot to ⅞ in. × ⅞ in. of 0.7 lbs. per foot, with reverse bars varying from 1⅛ in. × 1⅛ in. of 1.3 lbs. per foot to ⅞ in. × ⅞ in. of 0.7 lbs. per foot.

The outside plating is worked flush, with seam strips on the outside, the sheer strakes being 6¼ lbs. per foot on the boats for the *Maine*, and 5 lbs. per foot for those for the *Texas*. The rest of the plating is 3¾ lbs. per square foot or about three-thirty-seconds of an inch in thickness. The decks are to be of steel, covered with linoleum.

In addition to the torpedo armament, each boat is to carry a 1-pdr. rapid-fire gun, with a suitable supply of ammunition.

Each boat has a single vertical quadruple-expansion engine,* working at a pressure of 250 lbs., the cylinders placed in order of size over the shaft, the high-pressure cylinder being forward.

The following table gives a recapitulation of the principal dimensions of the machinery:

		Maine.	*Texas.*
Diameter of Cylinders.	High	6 in.	5.25 in.
	1st intermediate	8.37 in.	7.25 "
	2d intermediate	11.75 "	10.00 "
	Low	15.75 "	14.00 "
Stroke in inches		8	8
Condensing surface, sq. ft		150	116
Revolutions per minute		675	675
Indicated H. P.		200	155
Type of boilers, Mosher		Tubulous.	Tubulous.
Steam pressure, lbs		250	250
Grate surface, sq. ft		12	9.25

The estimated speed for the *Maine's* boats is 18 knots, and for the *Texas'* boats, 17 knots.

The machinery, as well as the hull, is kept as light as possible consistent with the strength required. The weight of the machinery, water, and stores being 11,990 lbs. for the *Maine's* boats and 9,900 lbs. for those of the *Texas*.

The shafting hardly amounts to more than a pipe, its thickness being only three-eighths of an inch. It was necessary to make the external diameter of sufficient size to secure a good bearing surface for the journals. As this would give a strength considerably in excess of the actual requirements if solid, it has been possible to make a relatively large hole. In large shafting the internal diameter rarely exceeds 50 per cent. of the external, while in this case it is more than 75 per cent. A great deal of attention has been given to the question of the stability of these boats, weights being kept as low as possible to give a good metacentric height. The 18-in. Whitehead torpedo, which weighs 875 lbs. with its tube and launching gear, is a little over half a ton. This weight being considerably above the water-line, it was necessary to keep the other weights as low as possible. The engines were located and the framing of the boats so arranged that the cranks would revolve between the floor-plates of the transverse framing, thus lowering the centre of gravity of the engine to the lowest possible point.

The results of calculations for stability are as follows:

At normal condition, ready for service with ammunition, torpedo and crew of five men on board:

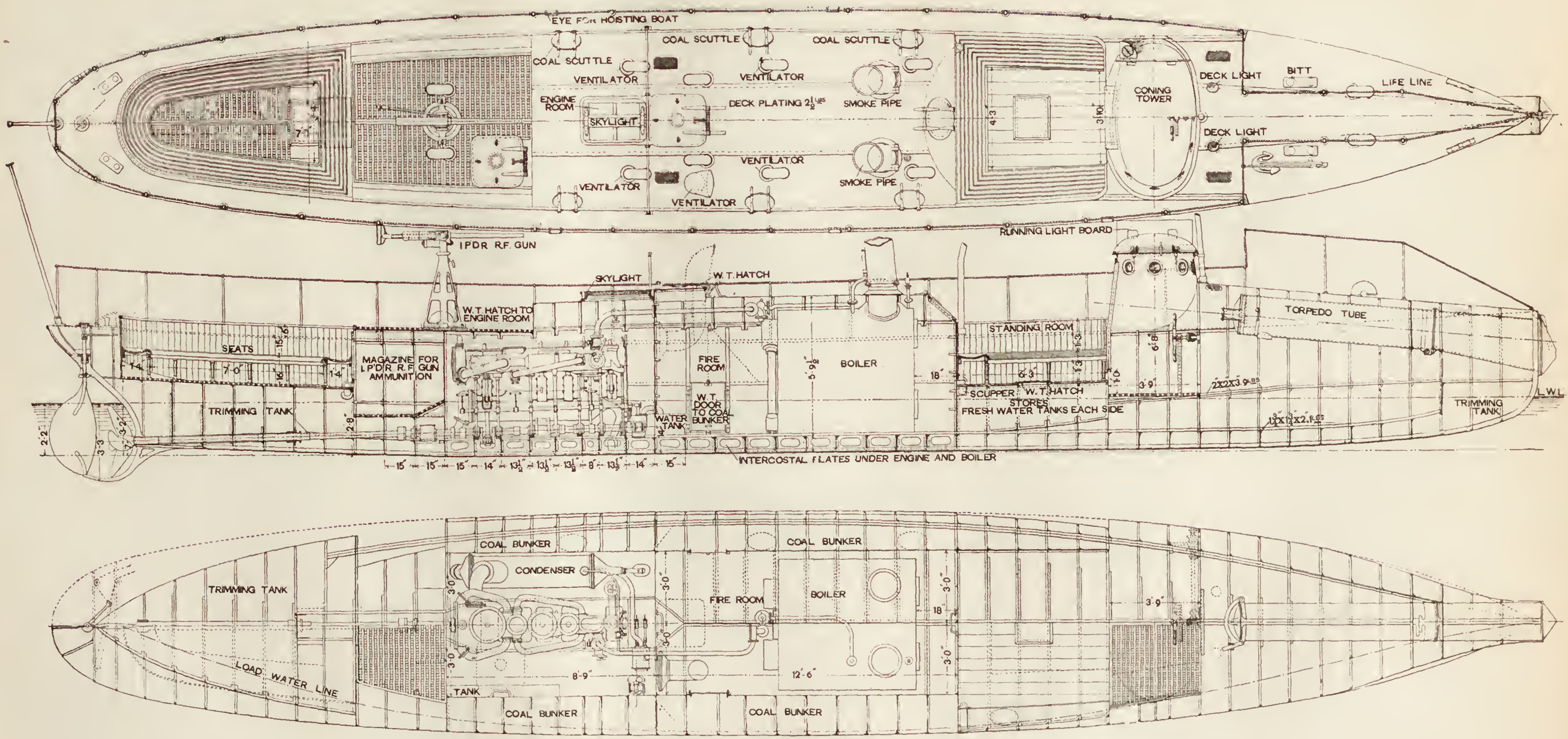
	Maine.	*Texas.*
Metacentric height	1.55 ft.	1.5 ft.
Angle of heel at maximum stability	43°	36°
Righting moment at maximum stability	27,135	16,308
Angle of vanishing stability	89°	73½°

With 30 men on deck in addition to weight at normal condition:

* See American Engineer for October, 1894.

Photographed by Hart, Brooklyn, N. Y.

THIRD-CLASS TORPEDO-BOAT FOR THE UNITED STATES ARMORED CRUISER "MAINE."



DECK PLANS AND LONGITUDINAL SECTION OF THIRD-CLASS TORPEDO-BOAT FOR THE UNITED STATES ARMORED CRUISER "MAINE."

	Maine.	*Texas.*
Metacentric height	1.00 ft.	.80 ft.
Angle of heel at maximum stability	36°	30°
Righting moment at maximum stability..	18,400 ft.-lbs.	7,875 ft.-lbs.
Angle of vanishing stability	67⅛°	52½°

Calculations for strength of the boats for the *Maine* at their weakest section have been also made. These developed the fact that the strain on the upper part of the boat, or at deck, when on the crest of a wave, would be 0.64 tons, or about one-fortieth of the tensile strength of the material used in the construction of the boats.

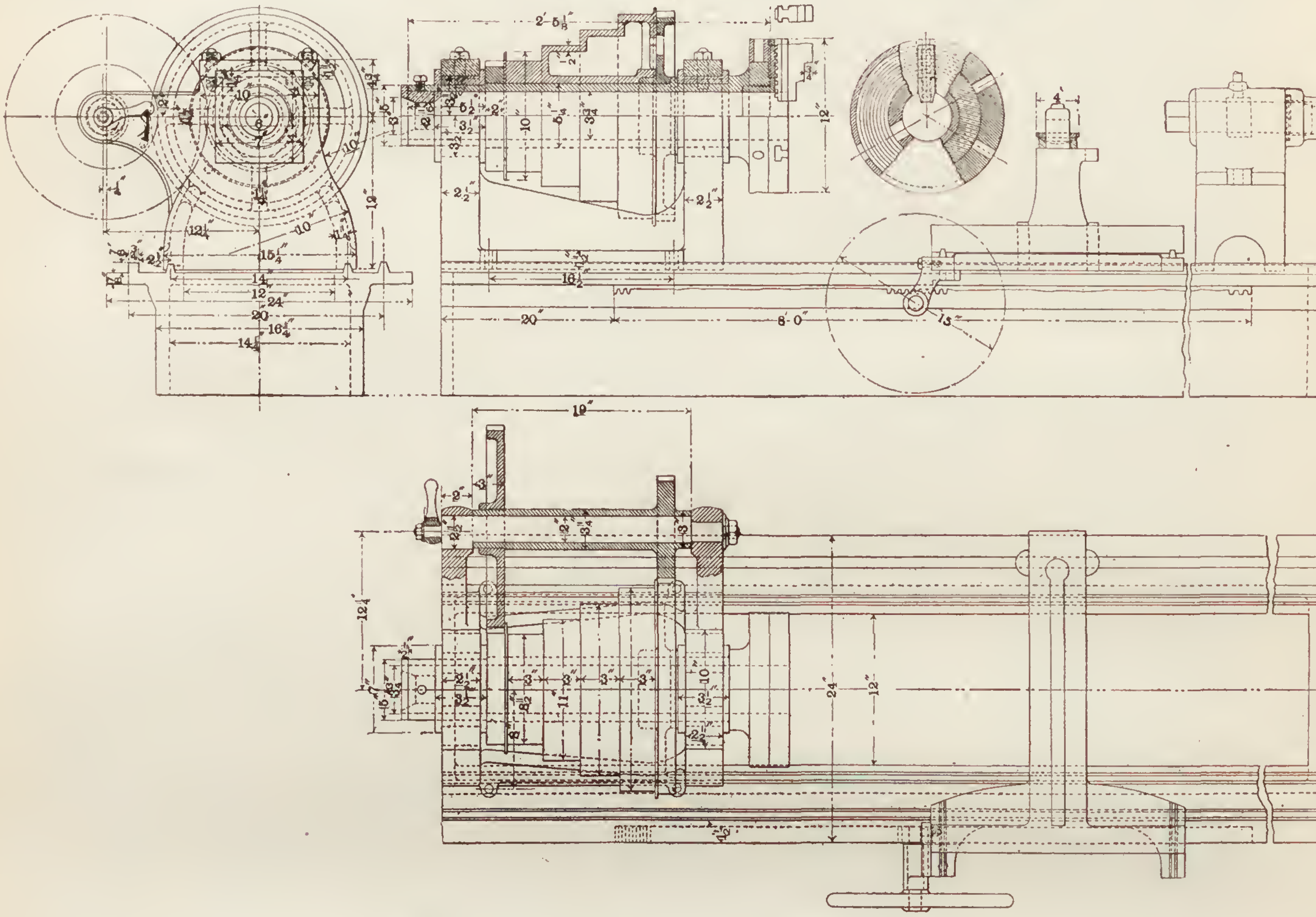
While the primary object of these boats is their use as torpedo-boats, cockpits with considerable seating capacity have been provided so that they can be used as fast dispatch boats, or barges for the admiral of the fleet.

As we noted in our previous description of the engines, the engine and fire-rooms are in separate compartments, and there is no means of passing from one to the other except by way of the deck. This means that the men are confined in very cramped quarters, where it is absolutely essential that the ventilation should be as perfect as possible. Special attention has therefore been paid to the ventilation of the two compartments. The cowls are so arranged as to form downcasts and outlets; the downcasts being arranged well toward the forward end of the compartments that they supply with fresh air. The goose necks are of copper fitted to brass flange rings for connection with the deck plating. The downcast cowls are also made of copper and fitted to revolve, all mouths being fitted with water-tight covers.

PIPE-LATHE, PHILADELPHIA & READING RAILROAD.

Among the tools that have been built at the shops of the Philadelphia & Reading Railroad for home use is a pipe-lathe, of which we give an engraving herewith. While the tool does not vary greatly from others that are upon the market, it is a sample of a good design that does its work well and is giving satisfaction in the place for which it was intended. The bed is of the box type, exceptionally rigid and heavy, the ways of which for the head and tail stocks and carriage extend the whole length. The headstock is also heavy and of such a contour that the requisite strength was obtained with the minimum of work on the patterns. The spindle is hollow, with an internal diameter of 3¾ in. The outside diameter between the bearings is 5¼ in., which is also the diameter of the front bearing, while the back is cut down to 5 in. The length of each of the bearings is 3½ in. The brasses are faced and brought metal to metal along the centre line. The spindle projects 2 in. beyond the brass at the outer end, where there is a threaded hole to take a set screw for holding the bushing that is inserted to fit the work and keep it in line. The back gearing has a uniform face of 2 in. and a pitch of ½ in.

The carriage has a long bearing on the front ways, and is moved by a pinion meshing into a rack 8 ft. long and having a pitch of ½ in. By referring to the drawing it will be seen that the dimensions are very fully given, so that a recapitulation of them will be unnecessary.



PIPE-LATHE, PHILADELPHIA & READING RAILROAD.

THE MICRO-METALLOGRAPHY OF IRON.

By Thomas Andrews, F.R.S.

In the course of a research with high microscopical powers (including 300, 500, 800, 1,200, and upward to 2,000, diameters) on the micro-crystalline structure of large masses of wrought iron, the author observed the following novel metallurgical facts:

When large masses, several tons in weight, of practically pure wrought iron were allowed to slowly cool from a white heat, a secondary or subcrystallization of the metallic iron occurred. The normal primary crystals of the iron, or those which have hitherto been regarded as constituting the ultimate structure of the metal, were found to enclose a subcrystalline formation consisting of very minute, and much smaller crystals of pure iron also belonging to the regular order of crystallization. These crystals sometimes manifested the hexagonal form, the predominant angle being about 120°, and often they assumed the form of simple cubes. The secondary crystals were contained within the area of the larger primary crystals.

Typical illustrations of this duplex crystallization found in two large iron forgings are given in figs. 1 and 2, and the relative dimensions of a number of individual crystals are given in the paper.

The results of twenty measurements of the primary crystals

and twenty measurements of the secondary crystals taken on each forging are given on these tables.

The markings of the intercrystalline spaces or junctions of the secondary crystals were very clearly defined, but they were exceedingly minute. The general form, contour, and relative size of the primary and secondary crystals, as seen in section, will be noticed on reference to the accurate tracings, figs. 1 and 2. The linear dimensions of the primary crystals would average about 0 01 in., the linear dimensions of the secondary crystals averaging about 0.001 in.

Judging roughly from the indications of the average micro-measurements, there would appear to be approximately 1,000,000,000 of the secondary crystals in a cubic inch of the metallic iron.

In the case of both the primary and secondary crystals the predominant well-defined angles of the facets of the crystals hovered more or less about the angle of 120°. The majority of the angle readings, made with the goniometre attached to the microscope, indicating generally a hexagonal structure on form of crystallization. There were, however, also perfect cubical crystals observed.

The observations were made with a Ross first-class microscope. The micro-measurements afford an indication of the comparative size of the primary and secondary crystals. These measurements were carefully taken by a Jackson micrometre, and in some cases by a Ramsden screw micrometre, both accurately calibrated with a standard stage micrometre. The wrought-iron forgings on which the observations were made were constituted of practically pure hammered wrought iron, the dimensions of the mass being about 10 ft. long and about 12 in. square. The great length of time required for

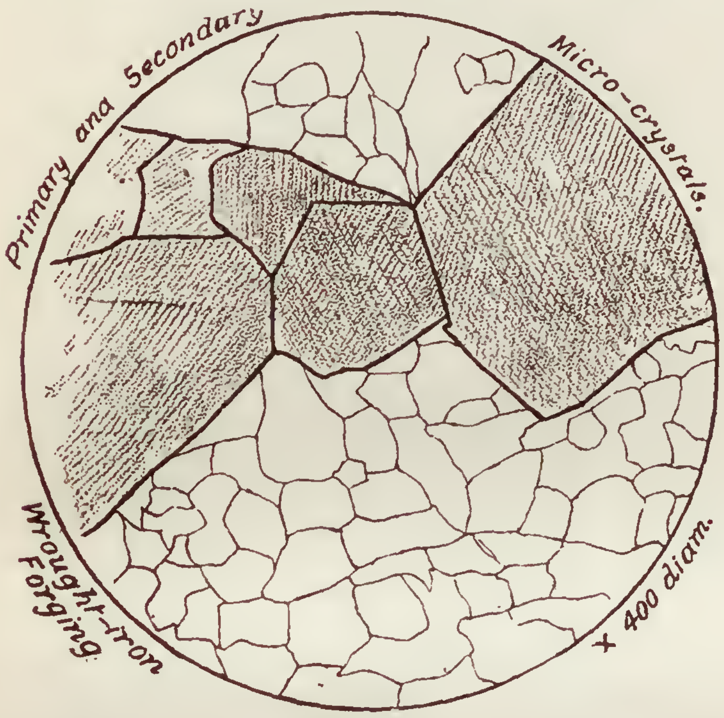


Fig. 1.

such large masses of iron to cool from a white heat appeared to facilitate the production of the crystals of the secondary formation.

The *rationale* of this duplex crystallization has apparently been as follows: The mass of metallic iron on cooling having reached the crystallizing point at about 740° C., the periphery or skeletons of the larger or primary crystals were then formed. As the period of cooling was, however, very slow, the semi-fluid or viscous metal in the interior of these primary crystals was, on finally consolidating, apparently further broken up or subdivided into a considerable number of smaller crystals, enclosed within the boundary or periphery of the primary crystals.

In the course of further experiments on the cooling of large masses of wrought iron, the author has also found, by the use of high power objectives, that the secondary crystals sometimes enclosed a still more minute form of crystals of pure iron, of the cubical form, which may hence be regarded as constituting a tertiary system of crystallization in pure metallic iron. These experiments therefore indicate that large masses of heated wrought iron, on cooling from above the temperature of the crystallization of metallic iron—viz., 740° C.—are capable of crystallizing in three distinct modifications which may tentatively be called the primary, secondary, and tertiary system of crystallization in iron, these various crystalline modifications being all, however, connected with the regular system of crystallization.

The crystals of this secondary formation are not often distinctly discernible in smaller masses of metallic iron, such as rolled rods, plates, or sheets, as these in the course of manufacture rapidly cool, and are frequently manipulated during the finishing processes at temperatures below the crystallizing point of wrought iron (740° C.).

The microscopical examinations were made on carefully prepared and polished samples, etched with nitric acid (1 part HNO_3, specific gravity 1.20, and 49 parts of water), and by the use of high microscopical powers $\frac{1}{8}$ in. to $\frac{1}{10}$ in., and other objectives. The drawings were accurately made with the *camera lucida*. In each observation the etching was prolonged, under constant observation with lenses, a suitable time to develop the accurate structure of the metal.—*Nature.*

WRECKING-CAR—CENTRAL VERMONT RAILROAD.

The accompanying illustration on page 368 represents a wrecking-car that is in use on the Central Vermont Railroad, and which was built at the St. Albans shops of the Company. It is carried on two four-wheeled diamond trucks, the upper and lower arch-bars of which are formed of 1 in. × 4 in. iron, and the auxiliary and tie-bars of $\frac{3}{4}$ in. × 4 in. iron. The side sills of the car are 8 in. × 15 in. Georgia pine; the intermediate sills are formed of two timbers placed side by side and each 10 in. × $5\frac{1}{2}$ in., while the centre sill is in one piece as usual, 10 in. × $6\frac{1}{2}$ in. The brakes are hung outside the wheels, and are attached to the body of the car. The body bolster is formed of a piece of timber 6 in. deep × 16 in.

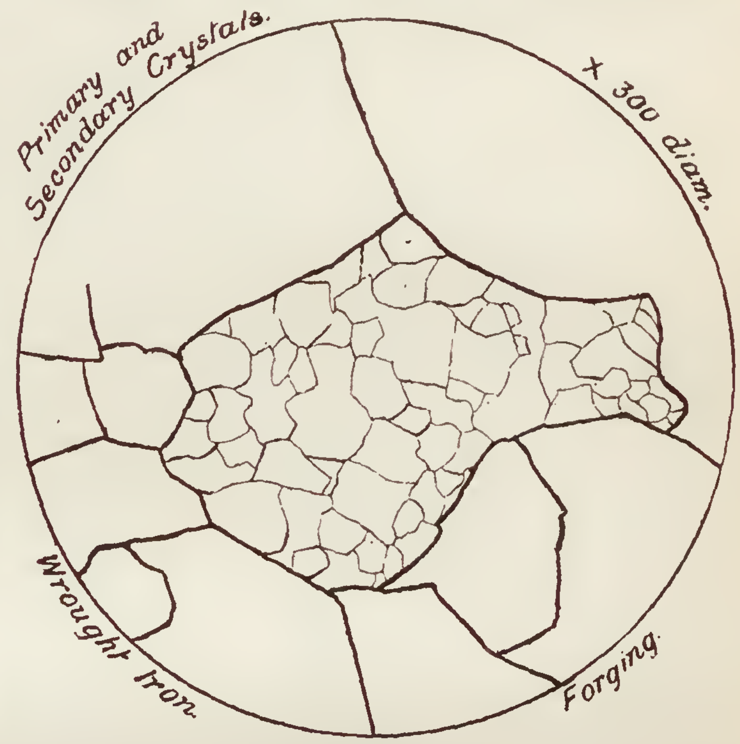
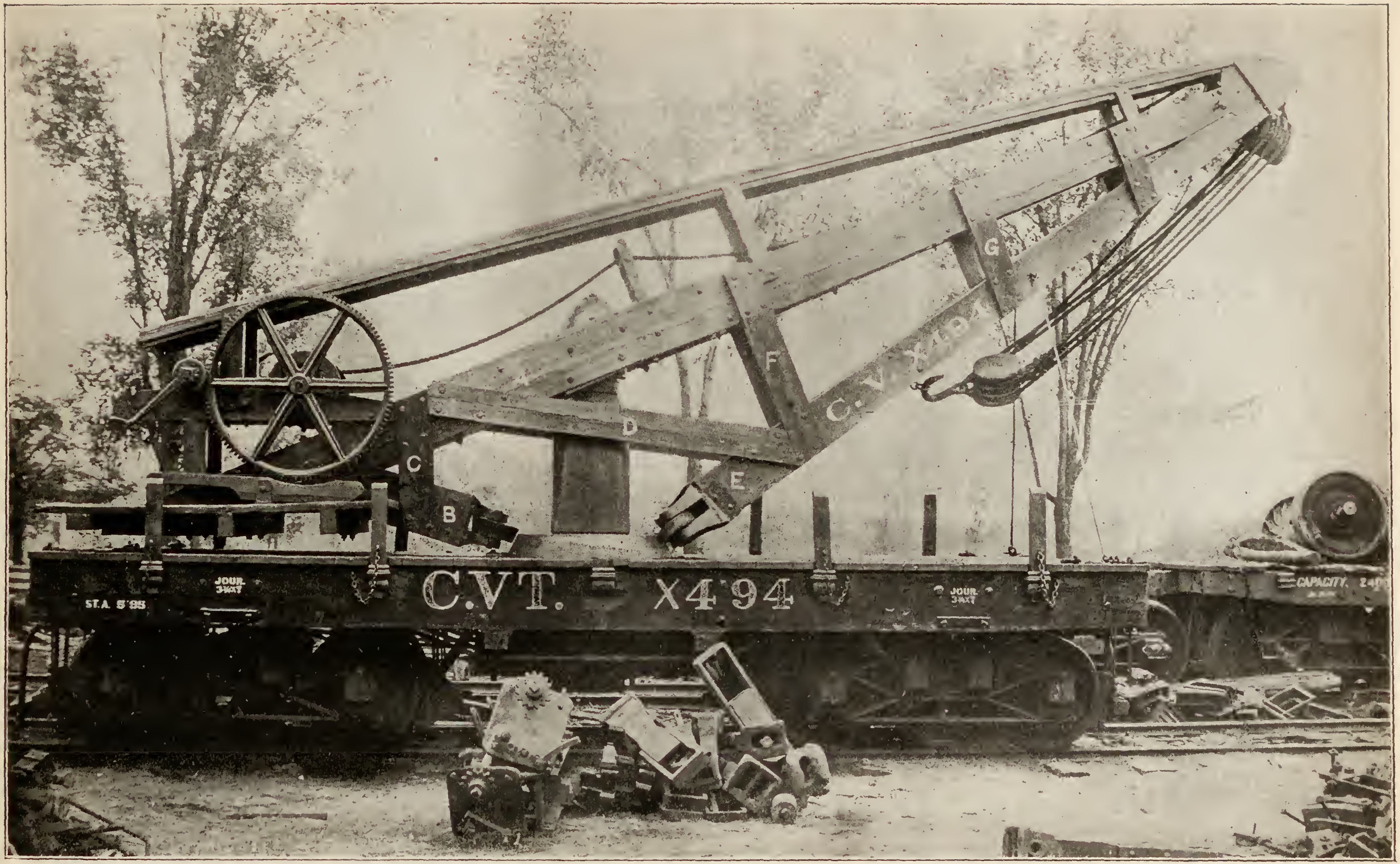


Fig. 2.

wide, and trussed by two $\frac{7}{8}$-in. truss rods. The old type of wooden brake-beams are in use, and the truck, which is of the swing-bolster type, has a transom $9\frac{1}{4}$ in. deep. The cross-tie timbers are 6 in. × 10 in., dropping down $4\frac{1}{4}$ in. below the bottom of the side sills and carrying the king posts for four $1\frac{1}{4}$ in. truss-rods. Filling pieces are placed above the cross-tie timbers, taking up all of the space between them and the bottom of the flooring. There is a longitudinal timber 10 in. × $4\frac{1}{2}$ in. running from one cross-tie timber to the other, and carried in part by two $\frac{1}{2}$-in. × 3-in. slings that are bolted to the bottom of the side sills. On the top of these timbers, and equally spaced between the cross-tie timbers, are two cross-beams that hold the post of the crane in position. The whole space over the top of the longitudinal beams and between the cross-tie timbers is blocked in, and to it is bolted the bearing casting at the foot of the boom. This casting is 4 ft. 8 in. × 4 ft. 2 in. at the base, with a diameter of 3 ft. 11 in. at the bottom of the inclined bearing and a diameter of 3 ft. $3\frac{1}{2}$ in. at the top of the same. The post is 20 in. square at the top of the casting, and is capped by a cast bearing piece over which a cast hood is bolted and on which the boom rests. It is also strengthened by a band of 3 in. × $\frac{1}{2}$ in. wrought iron put on just below the cap. The foot of the boom sets in cast-iron pockets that carry the bearing rollers, which are of a conical shape and work against the centre plate, as shown in the engraving.

The sizes of the timbers used in the construction of the crane are indicated by the letters on the engraving, and are given in the following schedule:



WRECKING-CAR, CENTRAL VERMONT RAILROAD, BUILT AT THE ST. ALBANS SHOPS.

A	14 in.	× 5 in.
B	13 in.	× 4½ in.
C	9 in.	× 4½ in.
D	9 in.	× 4½ in.
E	13½ in.	× 4½ in
G	3½ in.	× 4½ in

On the top of the piece *A* extending from the connection of *C* to midway between *F* and *G* a piece of 1¼ in. × 3½ in. flat iron is bolted. The two pieces of the beam are held apart by six separating pieces.

A 1¼ in. (diameter) manilla rope is used that is given seven supporting parts by means of a three-sheave block and fall. The winding drum has a diameter of 10 in. and a length between flanges of 2 ft. It is upon the same shaft as the large gear-wheel shown in the engraving, and upon which the brake-block is made to bear, just as it does in the wrecking crane of the Philadelphia & Reading Railroad, that was illustrated in our issue for April, 1895. This winding shaft is also provided with two ratchet wheels with pawls fastened to the framing for sustaining the load. The large gear has a pitch diameter of 4 ft. with 120 teeth of 1¼ in. pitch. The pinion on the crank-shaft has a diameter of 8 in. and 20 teeth, the face of both the pinion and the gear being 3¾ in.

The cranks are 19 in. long, so that it will be seen that 1 lb. on the crank-handle will sustain about 80 lbs. at the hook. The cranks are of sufficient length for two men to work side by side upon them.

A box that cannot be seen in the engraving is located at the foot of the boom for the reception of straps, clamps, stays, etc. The brake staffs at each end of the car are square and drop down into a socketed casting out of the way. Hooks are placed on the dead woods at each end of the car for clamping the same down to the rails.

The car is equipped with the Westinghouse air-brake, so that it is in shape for running upon fast trains.

SPECIAL TOOL FOR TURNING BALL-REAMERS.

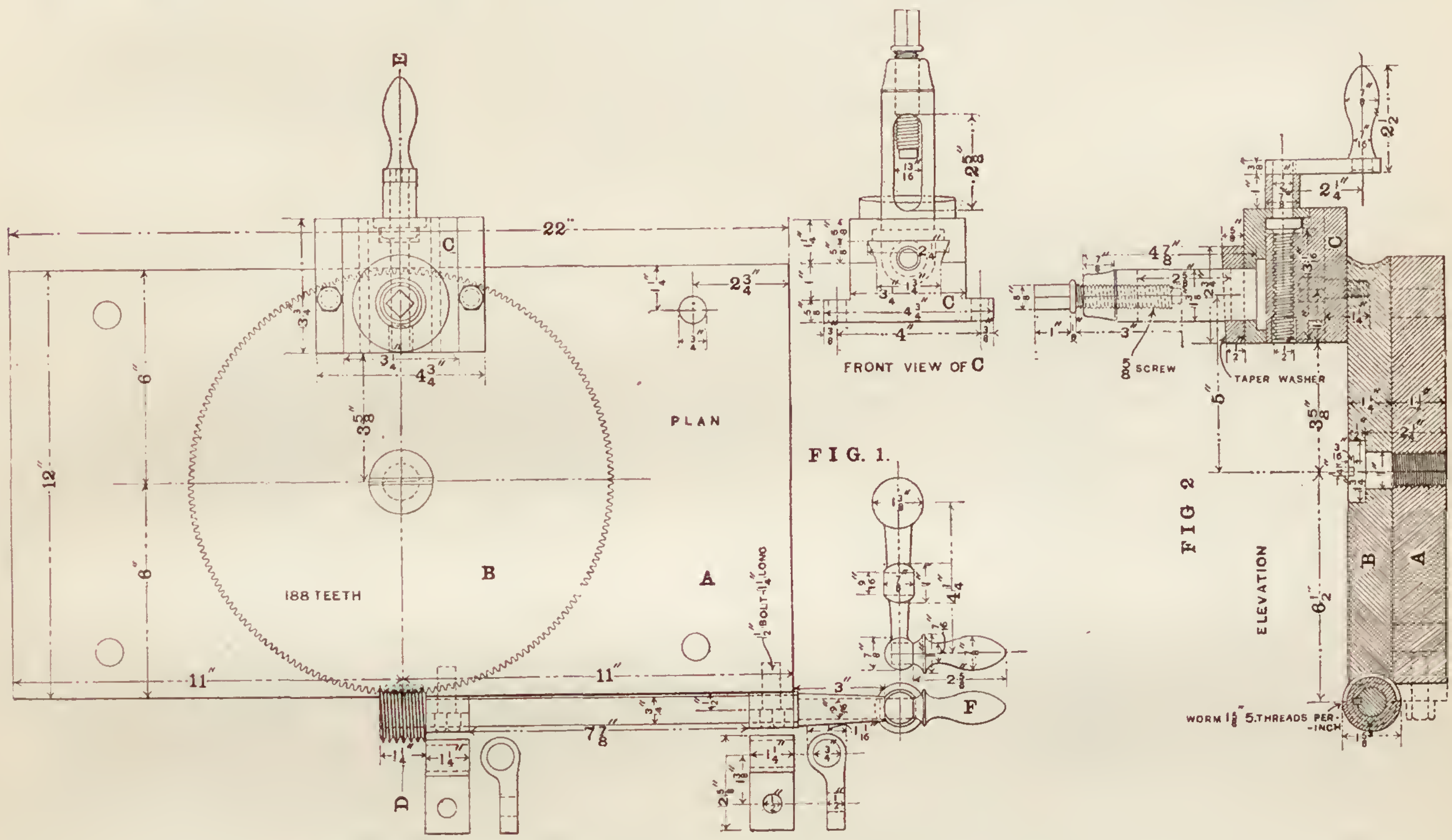
The attached sketch shows a special tool used by the Baltimore & Ohio Railroad Company for turning ball-reamers—that is, reamers used in balling out steam-pipe joints, etc., and is composed of plate *A*, worm-wheel *B*, slide-rest *C*, and is operated by handle *F*. This tool was designed some years ago by Mr. John Litzinger, who has charge of the tool room for this Company. The mode of operation is as follows:

1. Remove the slide-rest from the carriage of the lathe you intend to turn the ball-reamer in and fasten the special tool to the lathe-carriage with four bolts, passing through bolt-holes shown in plate *A*, and level it properly.

2. Put the ball-reamer to be turned, between the lathe centres with a carrier attached to the shank, the same as you would a straight piece of work.

3. Put a lathe tool in the tool post attached to slide-rest *C*, and by setting the point of the lathe tool any distance from the centre of worm-wheel *B*, and by operating handle *F* it can readily be seen that the point of the lathe tool will describe any radius required within the capacity of the machine.

This tool is used mostly for the purpose of truing off the cutting edges of ball-reamers when they are much worn; it is possible with this tool to take off a very light cut from the cutting edges of the reamers, after which they can be filed to a cutting edge without much delay, and always insure as perfect a ball as it is practicable to get; where with the old templet it is almost impossible to get a satisfactory ball, especially in the case of truing off old ball-reamers.



SPECIAL TOOL FOR TURNING BALL-REAMERS, BALTIMORE & OHIO RAILROAD.

THE DOWN-DRAFT FURNACE FOR STEAM BOILERS.*

By William H. Bryan.

Probably no mechanical device has done as much toward the practical solution of the smoke problem in St. Louis as the down-draft furnace. Until this apparatus was developed there was a certain character of steam plants—or, rather, of steam service—to which it seemed that none of the existing forms of smoke-abating furnaces could be satisfactorily applied. In these plants—fortunately few in number—the demand for steam was such as to make it necessary at times to crowd the boilers far beyond their rated capacity. Or else the work was subject to frequent and extreme fluctuations, often greatly exceeding the rated capacity of the boilers. It may be said, of course, that this is abuse, rather than proper use, of a boiler plant, but, nevertheless, these conditions exist, and it is sometimes impossible either to modify the conditions or increase the boiler capacity.

The fact that there seemed no practicable or reasonable remedy for these cases retarded the growth of the smoke-abatement movement in St. Louis for many years. It was thought unwise to pass and attempt to enforce smoke-abatement ordinances when it seemed impossible for some of the plants to stop the smoke, under reasonable conditions. The demonstration of the fact that the down-draft furnace made a good smoke record possible, even with overworked boilers doing variable work, and with a marked economy in fuel,

* Presented at the Detroit meeting (June, 1895) of the American Society of Mechanical Engineers.

may be said to have marked an epoch in smoke abatement. Our experience in St. Louis leads us to believe that smoke from boiler furnaces can now be abated by practical means, without hardship, no matter what the type of boiler, the character of the work required of the plant, or the kind of fuel used.

I speak thus highly of the down-draft form of furnace with no intention of denying the merits—for they are many—of other smoke-abating devices. Many of these do excellent work under most of the conditions occurring in practice. In my opinion, however, no single furnace now on the market can be adapted to all the conditions met with in every-day boiler service. Each type has a place, a field of usefulness, within which limits its success is sure. Unfortunately, however, the average furnace man seems unable to realize this truth, but offers his device as a remedy for all sorts of cases and conditions. It is not surprising, therefore, that he sometimes meets with failure.

Where the work required of a boiler plant does not greatly exceed its rated capacity, and is reasonably uniform, there are many good smoke-abating furnaces which may be used, some of which will make an appreciable saving in fuel. If our boiler plants were properly designed and managed, and if we did not have sometimes to overwork them, and to subject them to widely varying loads, the smoke-abatement problem would be greatly simplified. The fact, however, that even such discouraging conditions as these can now be intelligently remedied, has led to the preparation of this paper.

Fortunately for the steam-using public, several different forms of down-draft furnaces are offered for sale, by various builders, and under different patents. I have had no opportunity of looking up the number and value of these patents, but it would seem that they refer to important details of construction and arrangement, rather than to general or essential principles. It is not necessary to consider here whether or not the manufacturers are justified in charging royalties. Their experience in the design and adaptation of the furnace to varying conditions—and the further fact that, as a rule, they will guarantee results—would certainly appear to entitle them to a fair margin of profit, at least.

Although the principles are old, I have been unable to find any record of this type of furnace coming into regular use previous to 1888. It seems that the cost of the apparatus, the necessity for water grates, and their frequent burning out, due to defective construction and bad feed-water, prevented its general adoption.

The form of down-draft furnace which has come into most general use, and which may justly be said to have contributed more than any other to the present state of the art, is that invented by Mr. M. C. Hawley, of St. Louis, and which bears his name. Mr. Hawley's experiments began as far back as 1873, and met with varying degrees of success. He was able to show an economy of fuel, and, with proper handling, an almost total abatement of the smoke, even with the low-grade soft coals common in the Mississippi Valley. In 1882 Mr. Hawley interested Captain C. W. Rogers, then General Manager of the St. Louis & San Francisco Railway, who, after consultation with his Master Mechanic, decided to build an experimental furnace in the fire-box of a switch engine. The result was so satisfactory that the furnace was soon applied to another locomotive boiler in stationary service. It was then applied to a locomotive in regular service. It was necessary to greatly cut down the grate area, but in spite of this the engine did good service, being practically smokeless and throwing no sparks, even with a straight stack and no netting, until destroyed by a roundhouse fire. The furnace was also applied to a number of the boilers of the St. Louis & San Francisco Railway Company, in stationary practice, in their shops and other buildings, where they are still running satisfactorily. In 1888 a contract was made to place the Hawley furnace under an ordinary stationary boiler in the new factory of the Hamilton & Brown Shoe Company, St. Louis, under a very stringent guarantee. The boiler was 60 in. in diameter, 20 ft. long, with 18 6-in. flues. A similar boiler was set with the ordinary furnace, in the same room. The results in smoke abatement, fuel economy, and capacity were so satisfactory as to lead to the application of the Hawley furnace to the other boiler very shortly afterward. This case marked the beginning of the introduction of this type of furnace into general stationary practice.

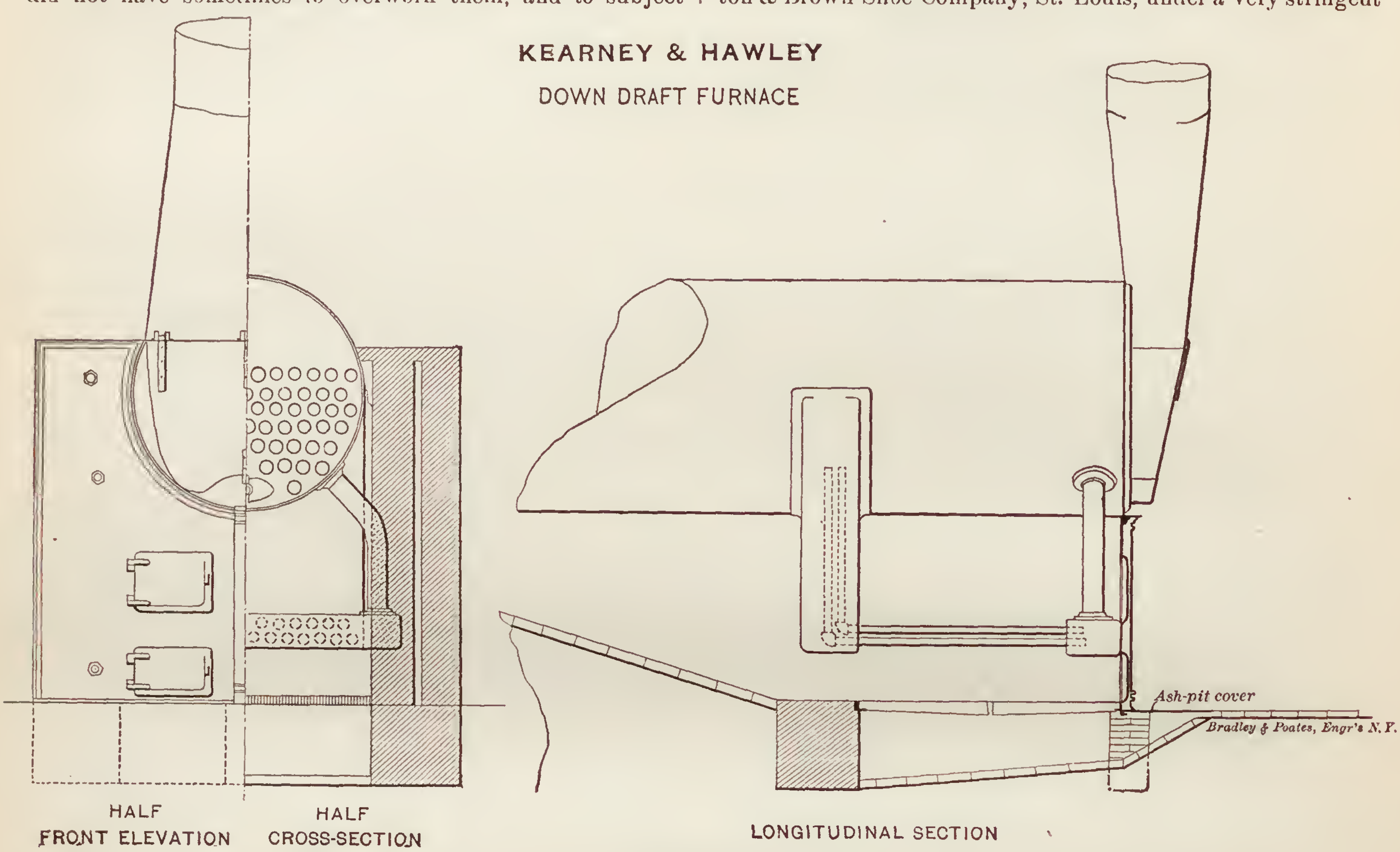


Fig. 1.

A brief description of the characteristic features of the Hawley setting will be of interest. In the earliest forms it consisted of a single row of water grates, these being necessary on account of the high temperatures developed. These water grates were made of 2-in. pipe, placed level, and connected with the circulation system of the boiler by water boxes, or headers, and connecting pipes. The supply pipe leading to the front headers was usually taken from near the bottom of the front end of the shell, and the discharge was delivered near the water-line. The rear end of the fireplace above the grates was closed off tightly, by means of a hanging water leg rivcted to the shell of the boiler, in which suitable openings had been cut. In order to insure circulation in the tubes and prevent their burning off, it was found necessary to have the rear end of each tube project far enough into the water leg to permit attaching an elbow, into which was screwed a riser,

reaching up into the main body of the water in the boiler. Further experiments showed that it was usually desirable to put in two rows of water grates, and to stagger them. Even then, however, a considerable amount of unburned fuel fell through the grates, and was hauled out with the ashes, unconsumed. This caused a loss of efficiency when the boilers were crowded, and led to the adoption of the lower grate, which is of the ordinary pattern. This form of the furnace is shown in fig. 1.

It was at the Hamilton & Brown Shoe Works, above referred to, that the necessity for the lower grate became evident, and where it was first applied by Mr. Hawley. It is now an accepted feature of all forms of the Hawley furnace, and to it, in my opinion, are largely due the excellent results secured in capacity, efficiency, and smokelessness.

In the earlier forms of the furnace the water grates were level. It was soon found that, by placing them on an incline rising to the rear, the circulation was much improved, and the probability of burning off tubes greatly reduced. This plan was then regularly adopted, and the pitch gradually increased until the standard is now 2½ to 3 in. per foot of grate length.

It was soon found, also, that the riser pipes in the rear water-box were a source of trouble. Sometimes they became disconnected from the elbows, and when new grates were put in it was difficult to attach the elbows and risers, on account of interference with the other risers and with stay-bolts. When the risers were not connected, the grates burned off in a short time. This proved a serious difficulty, requiring in a number of plants the almost constant presence of boiler

on account of the high temperatures to which it is exposed. No such accident, however, has occurred, so far as I can learn. Fig. 2 shows the St. Louis form of construction. It shows but a single row of water grates, this form still being frequently used, as being easier handled.

This figure also shows the present method of building the boiler fronts. In the early form, shown in fig. 1, the ashpit was wholly below the floor-line, and was extended out in front of the boiler front, that portion of it being covered with sheet-iron plates, which were removed when cleaning the ashpit. This arrangement proving unsatisfactory, it was replaced by the three-door front shown in fig. 2. This plan raised the average level of the upper grates to a point some 18 in. above that of the ordinary furnace, making it necessary for the fireman to lift the coal that much higher, and making the firing considerably more laborious. It has now become customary to raise the floor a little at a point some three feet away from the front (see heavy dotted line in fig. 2), thus permitting the fireman to stand at the usual level with reference to height of grate. It is desirable also to have the ashpit slope to the rear, to facilitate cleaning.

As will be clearly seen from the drawings, the operation of the down-draft furnace is directly opposite to that of the ordinary setting. Very little air is admitted below the water grates; the entire supply of coal, and practically all the air, entering above. The fire burns downward instead of upward, there being "no thoroughfare" except downward through the grates. The gaseous products of combustion, together with the finely divided carbon particles which form the visible smoke, are forced through the incandescent mass of coal,

LATEST FORM OF HAWLEY FURNACE

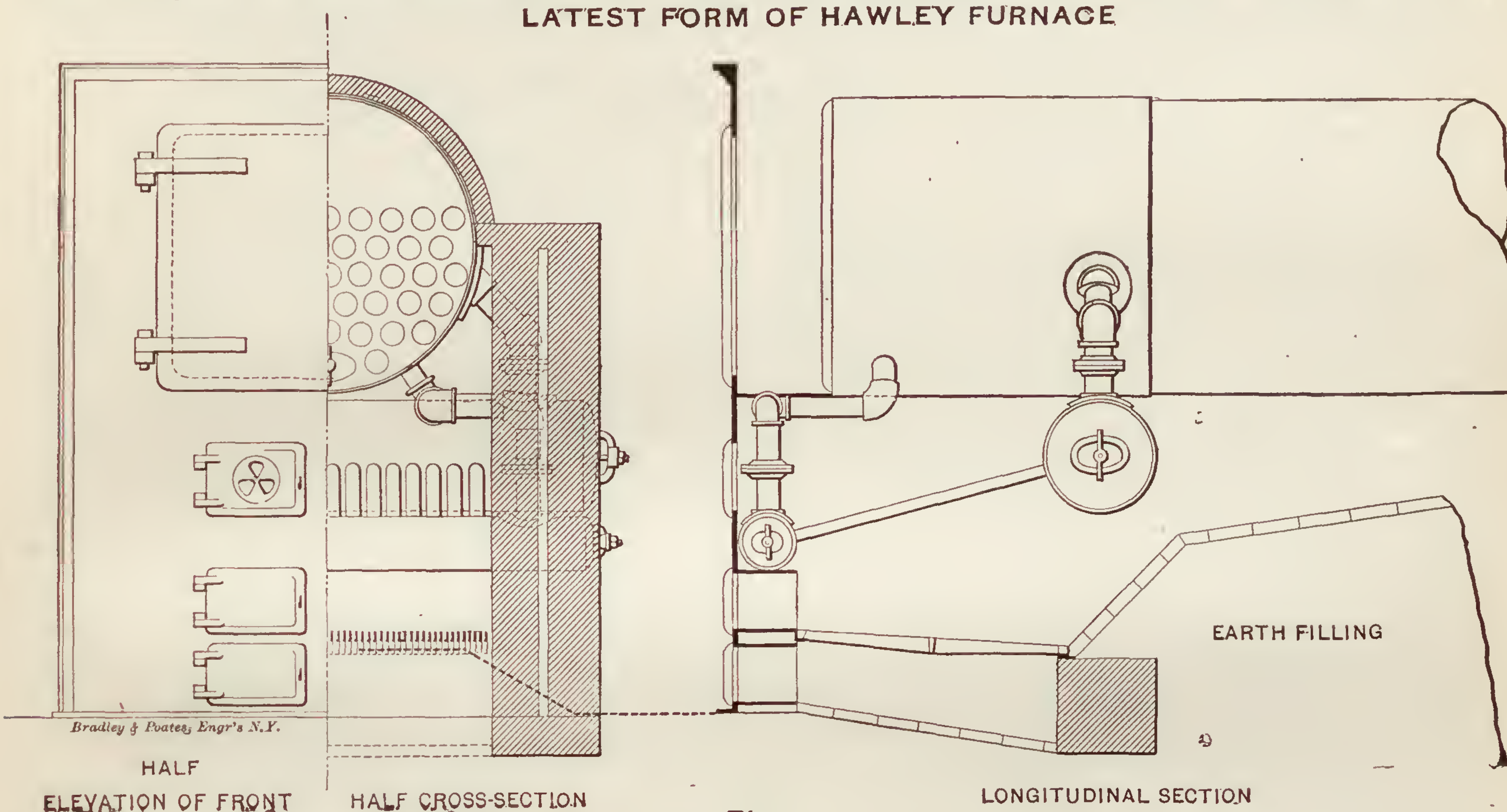


Fig. 2.

makers. Part of the boiler plant was therefore out of service a large portion of the time, and repair bills were large. Experiments were then made with other forms of construction, and a water-box, or header, was finally adopted for the rear end, similar to that used for the front end of the grates, the space intervening between it and the shell of the boiler being built up solidly by a 9-in. fire-brick wall. Connections were made from each end of the rear water-box to the boiler shell, some distance back from the front of the boiler, and just below the water-line. This expedient proved satisfactory, greatly reducing the number of tubes burning off.

This rear drum is now made in two forms. That adopted by the St. Louis manufacturers is simply a riveted drum 20 in. in diameter. This large radius permits the water grates to be screwed in, without the necessity of flattening the sides of the tube, as is customary with the form adopted by the Chicago manufacturers, whose rear drums are 10 in. in diameter. In the St. Louis form the drum is large enough to permit a man to enter it. By placing a light through a hand-hole into the front drum—which is usually 8 or 10 in. in diameter—it is possible to look through every tube, and thus ascertain its exact condition. The large drum, however, offers a favorable place for the accumulation of sediment, which may cause it to burn,

and are highly heated, after which they meet the equally hot flame from the lower grates, on which there is burning what is practically a coke fire. The combined water of the volatile matter in the coal, as well as its moisture, are decomposed into hydrogen and carbonic oxide gases. These combine with air supplied below the grate, or drawn downward through it, and burn, thus adding to the efficiency of the furnace instead of impeding it. The separated carbon meanwhile is transformed into carbonic acid gas, which is invisible. The result is almost complete combustion. Such little additional air as is needed is furnished through the registers of the doors between the two grates, or through those of the ashpit, the doors of which are sometimes left partly open also.

In practice it is found that, as an average, the upper grates do probably 90 per cent. of the work. When the boilers are not crowded little or no fuel is burned on the lower grates. When there is a demand for an increased amount of steam the fireman runs his slice-bar along or between the upper grates, causing a considerable amount of half-burned coal to drop through to the lower grates, where its combustion is completed.

It will be seen that the water grates and headers add somewhat to the heating surface, and thus increase the capacity of

the boiler. It has been found, however, that this reversing of the path of the gases, and requiring them to traverse the tortuous passages, makes necessary a somewhat increased

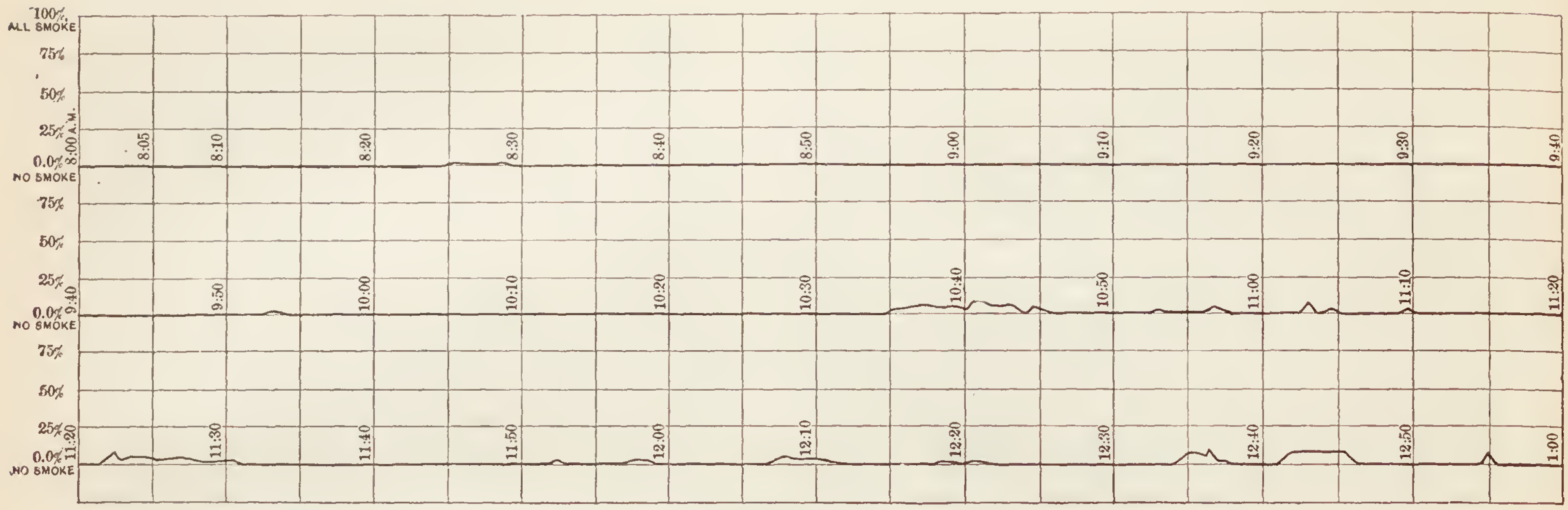


Fig. 3.

chimney capacity, if it is desired that the boilers be capable of doing as much work as with the ordinary setting. If the demand for steam never greatly exceeds the rated capacity of the boiler the ordinary chimney will answer, it simply being necessary to carry thinner fires. The best results, however, in efficiency and smokelessness, as well as in capacity, are secured by having a chimney of ample height; a statement, however, which is equally true with regard to ordinary settings, which rarely have enough chimney.

In order to make a fair and definite comparison of the Hawley down-draft setting with the ordinary furnace, the Smoke Commission of the city of St. Louis, of which the writer is a member, made a competitive test at the plant of the William J. Lemp Brewing Company, on July 11, 1893. The boilers were identical in every respect except as regards their furnaces, and that the chimney for the down-drafts was 143 ft. high, and for the common battery 100 ft. high, above grate level. In both cases the boilers were run at more than double their normal rating, and the efficiency of the Hawley was over 21 per cent. higher than that of the common furnace.

The smoke record (see chart, fig. 3) shows a reduction in the smoke of nearly 96 per cent., even under these extraordinarily severe conditions. Fig. 4 shows a chart made by the writer from the chimney of a Heine boiler, set with the Hawley furnace, at a time when the boiler was being run at 25 per cent. above its rating. It shows the remarkably low figure of only two-thirds of 1 per cent. of smoke—in fact, there was absolutely no smoke except while the fires were being cleaned.

It will be seen in figs. 1 and 2 that in the standard form of construction the fireplace is immediately under the front end of the boiler. This usually cuts off from 50 to 60 sq. ft. of valuable shell-heating surface, and, furthermore, must interfere largely with the circulation of the water in the boiler. In a few instances external fireplaces have been built, but their somewhat greater cost, the increased space occupied, the necessity for a special form of front, and the difficulty found in supporting the fire-brick arches over the water grates, have prevented the general adoption of this plan. In my opinion, however, it possesses important advantages in capacity and efficiency, and should be followed wherever sufficient space is available.

With the present form of water-drums and tubes there is but little danger of the tubes burning out unless the feed-water is bad. This is a point that must be carefully looked into when it is proposed to use the down-draft furnace. It is a matter, however, that should always have attention, whatever the type of boiler or setting; and as there are now so many good systems of water purification, there is little excuse for permitting heating surfaces to become foul with scale.

When the tubes burn out they do so without causing damage to the surroundings. Sometimes only the threads are stripped, and at other times the tube splits, resulting in a large, but not serious, leak of water. In such cases the boilers are generally

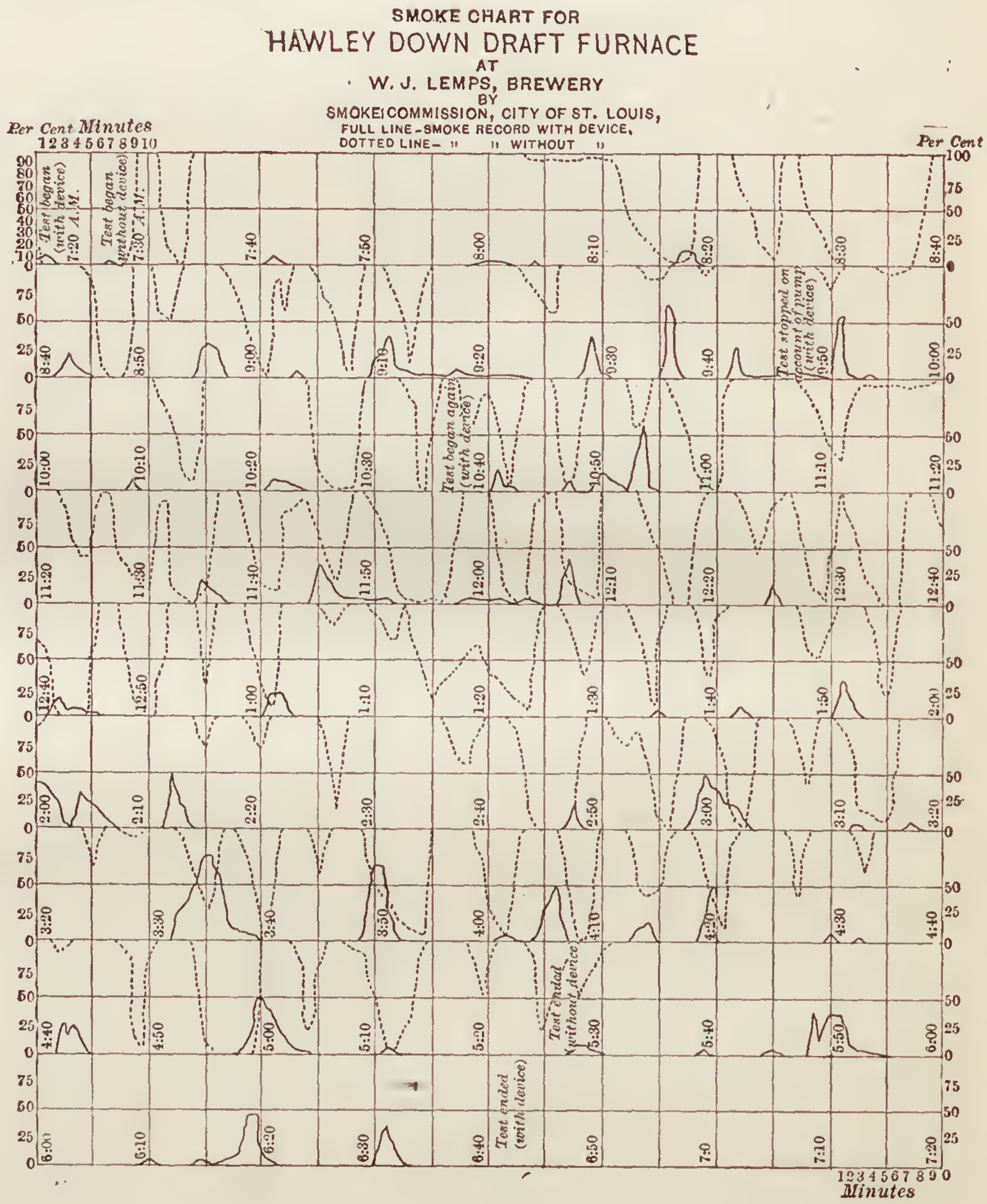


Fig. 4.

run in their regular service until the usual time of shutting down, and cases are on record where the boilers have been run until Saturday night—almost a full week. It is desirable, however, that at least one side of the boiler be accessible, in order to afford access to both drums, particularly with bad feed-water. This necessitates a passage-way between each pair of boilers.

A few cases of grate renewals have been due to careless or ignorant handling of the slice-bar by the fireman, bringing a severe cross-bending strain on the tubes. This, of course, must be carefully guarded against.

There being considerable special ironwork connected with the Hawley setting, this type of furnace is necessarily more expensive in first cost than some others. Measured in results, however, the advantages would, in most cases, appear to warrant a considerably greater investment than is ever required.

The conditions under which it would appear unwise to use the Hawley down-draft furnace for smoke abatement would seem to be:

1. Where the feed-water is quite impure, and cannot be readily improved.

2. Where the feed water is bad, and the boiler is not accessible from the side.

3. Where the draft is poor, and the boilers are hard worked. Usually, however, the height of chimney can be increased.

4. Where there is but a single boiler. The possibility of an occasional tube renewal might cause the interruption of the service for several days. This danger would be very remote with reasonably pure feed-water.

5. Where the plant is of such a size or character as not to warrant the investment.

Evaporative tests made by myself and others indicate that the Hawley furnace adds to the efficiency of improved water-tube forms of boilers, although the percentage of increase is not so great as with the ordinary boilers. The design of the furnace is such as to make it readily applicable to any form of boiler.

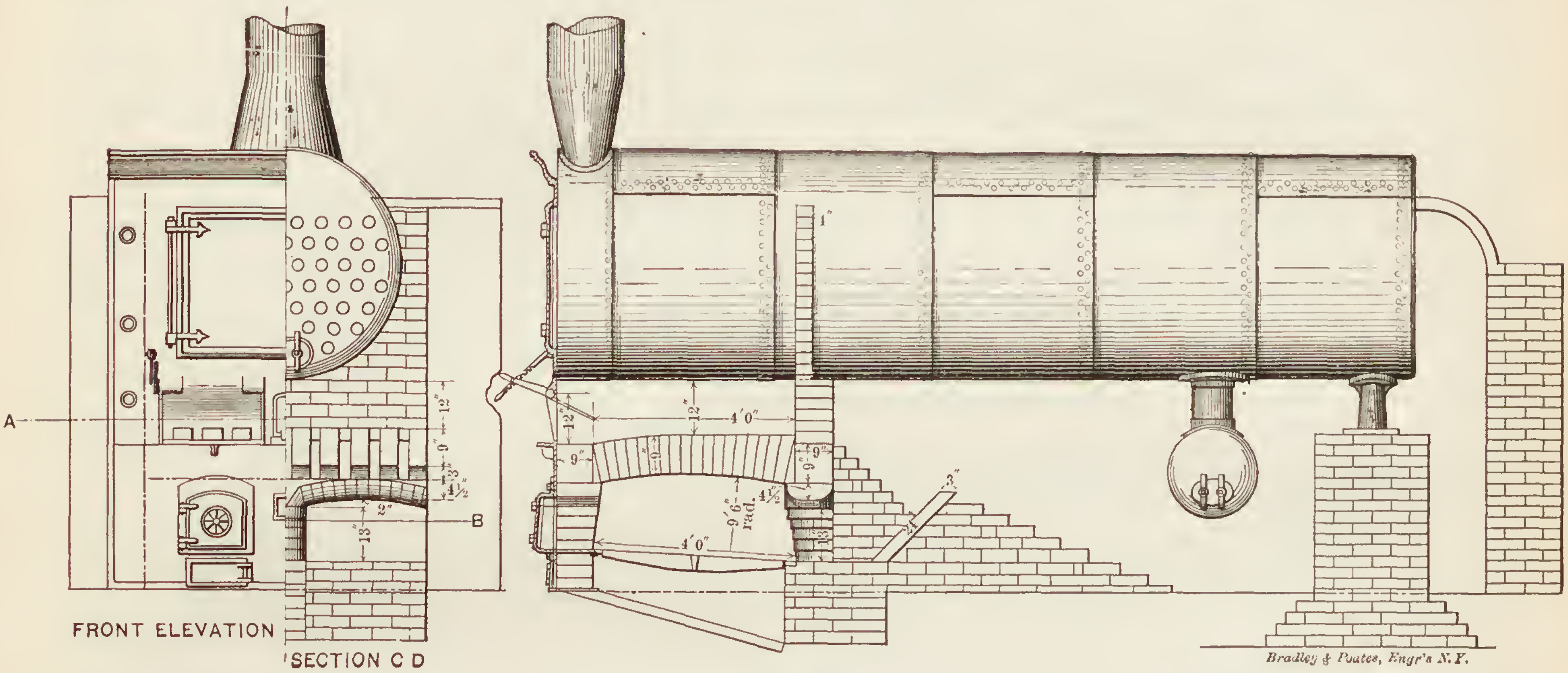


Fig. 5.

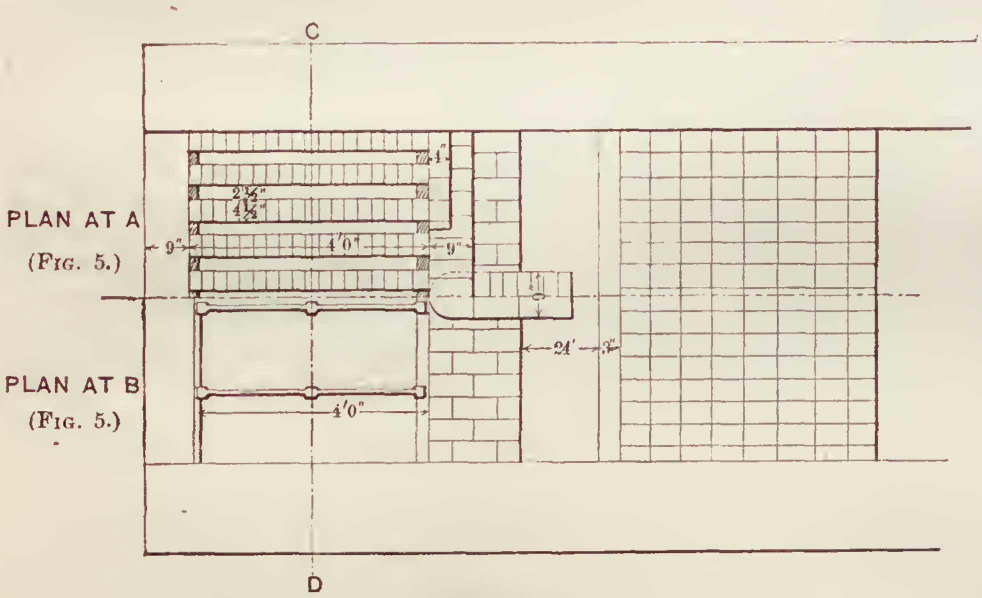


Fig. 6.

I recently prepared a series of instructions to firemen for a large plant operating the down-draft furnaces. These are appended hereto. It will be seen that the requirements are not at all difficult of comprehension and execution.

In some cases the use of this furnace has been found to add to the labor cost. This was due in a few cases to the increased height to which the coal had to be lifted, and sometimes to the debilitating effect of the radiant heat pouring out through the open fire-doors into the face of the fireman. Raising the floor level has remedied the former trouble, and the latter has been largely reduced by an improved form of door, which can be so placed as to keep the heat off the fireman, while still admitting an ample air supply. In other cases the draft was insufficient, and large demands for steam have necessitated increased labor. In still other cases the firemen have not thoroughly understood the best method of handling the fires, and have not directed their efforts to the best advantage. With the latest form of construction, proper draft, intelligent and careful handling of the fires, there would appear to be no reason why the amount of labor should be increased. On the contrary, it ought to be decreased, as there is less coal to be handled.

Not the least of the many advantages afforded by the down-draft type of boiler furnace is the fact that the heating surfaces are exposed to practically constant temperatures. There is no alternate heating and cooling, as is the case with the common setting, when the doors are opened to admit fresh charges of fuel. That this type of boiler setting is destined to widespread use is demonstrated by the fact that three companies alone have within the last five years applied it to 1,600 boilers, aggregating 240,000 H.P.

While the Hawley type of down-draft furnace is perhaps the best known, others are coming into use, which promise well, although none have, as yet, met with very wide adoption. One of these, invented by Mr. Joseph M. Thomas, of St. Louis, is shown in figs. 5 and 6. In essential characteristics it resembles the Hawley, the principal point of difference being the substitution of a series of fire-brick arches in place of the water grates.

It possesses two important advantages: First, the absence of any connection with the pressure system of the boiler, thus avoiding trouble from that source; and, second, the brick arches act as reservoirs of heat, and do not cool the fires as the water grates do. It would be reasonable, therefore, to expect higher temperatures, and increased efficiency and smokelessness. In two tests made by the writer on boilers set with and without the Thomas furnace, my expectations as to smokelessness and efficiency were fully realized. I had expected some loss in capacity, due to the necessarily limited percentage of air-space through the fire-brick grates, but in this I was agreeably disappointed.

The difficulty with this setting thus far has been the short life of the grates, varying from thirty days to six months, depending entirely upon the character of the service, and the care with which the firing is done. Where the boilers are crowded, or where the firemen are careless, the arches last but a short time. If their durability could be increased to an average of, say, four months—which ought to be possible with careful handling, if the boilers are not unduly crowded—the small expense and trouble connected with their renewal would be fully warranted by the improved results. Experiments are now in progress with a view of securing a more highly refractory material out of which to make the grates, and until this is found, no extended effort will be made to push the introduction of the furnace.

Another form of down-draft furnace has been developed by Mr. J. A. Baldwin, of Benton Harbor, Mich. It is similar in many respects to the Hawley, the principal difference being that, instead of admitting the air through open doors above the water tubes, it enters through ducts in the masonry side walls, thus being preheated to some extent. Part of this air is discharged above the water grates, and part below them. The lower grates, instead of being ordinary bars, consist of perforated wrought-iron plates. The preheating of the air should be an advantage, if it is not accomplished at the expense of some other desirable feature, such as smokelessness, capacity, or efficiency.

Only a few of these furnaces have been built, and I have had no opportunity of examining them myself, but I am told that they are doing good work. No accurate evaporative tests have been made.

Another form is that invented by Mr. W. S. Plummer, of St. Louis. Mr. Plummer has all his grate surface on one level, and divides it lengthwise into three parts. The two outer parts are of the ordinary pattern of up-draft grates, while the central portion consists of water tubes connected with the circulation system of the boiler. A solid brick wall blocks off the rear of the fireplace, and extends down to the bottom of the ashpit, except immediately under the rear end of the water tubes. There are two partition walls in the ashpit, running lengthwise, which separate the up-draft from the down-draft portion of the furnace. The firing is done just as in the ordinary furnace, but the only escape for the gases is downward through the central water grates. The plan is working satisfactorily on a small scale in St. Louis, and is now being applied to a large boiler plant, where its operation will be watched with interest. The difficulty would seem to be the necessity for great width of grate surface, it being necessary to get the entire amount of surface in one level, while, in the Hawley furnace, it is divided over two different parallel planes. An increase can, of course, be had by lengthening the grates, but this is not always desirable.

A somewhat similar form is that invented by Mr. E. M. Bosley, of St. Louis, and applied in several cases in connection with his "incandescent" internally fired boilers. He divides his fire-box into two parts, with the dividing line at right angles to the centre of the boiler. The front half consists of an ordinary up-draft grate. In the rear of this is a 10-in. front water drum or header, extending clear across the furnace, and connected by means of 2-in. water grates to a similar drum in the rear. An ashpit of the usual form is built under the front grate, and a closing-off wall above the rear drum. The fire is burned on the front grate in the usual manner, a bed of fire being also carried on the water grates. The path of the gases is up through the front grate in the usual manner, and down through the water grates in the rear. A lower ashpit permits access from the front to the space underneath the water grates.

Both the Plummer and Bosley forms of down draft furnaces appear to utilize the heating surface of the shell immediately overhead to better advantage than the Hawley, but, on the other hand, neither of them have the second grate located where it will catch and consume the droppings from the water grates. So far as I know, no exhaustive investigations or tests of either of these types of setting have been made.

There are other types of down-draft furnace, notably that of Post & Sawyer, of Boston, which I believe has been applied only in connection with their internally fired "complete combustion" boiler, and which does not use a lower grate. The other forms are, in general, modifications of those described here, being few in number and relatively unimportant.

The system in its best shape is not perfect. Much has been done during the last few years in improving details so as to increase the efficiency, durability and reliability of the apparatus, but there is room for further improvements. Even in its present condition, however, it is well worthy of the careful study of progressive engineers everywhere.

Instructions for the Operation and Care of the Hawley Down-Draft Furnace, to Secure Efficiency and Prevent Smoke with Illinois Coals.

PREPARED BY WILLIAM H. BRYAN, CONSULTING ENGINEER, ST. LOUIS.

Fire frequently and in small quantities. Break up the lumps to fist size. Fire on the upper grates only, carrying a bed of uniform thickness over the entire grate surface. Avoid thin or bare spots.

The proper thickness of fire-bed depends upon the intensity of the draft and size of the coal. Lump coal and good draft require a thick fire, say 8 to 10 in., while fine coal and poor draft may render it necessary to reduce the thickness as low as 4 in. Don't let the elevation of the grates at the rear deceive you, but be sure the thickness of the fuel-bed is the same there as at the front.

When slicing, be careful that no green coal falls through to the lower grates. Do not let green coal get to the under side of the upper fire next to the water grates. When slicing push the bar between or along the water grates, and draw it back again without disturbing the fire. Lift the slice-bar just enough to break the caked bed. Use the slice-bar as little as possible. Be very careful not to strain the tubes with the slice-bar.

See that the bed of coal on the upper grates does not get either too thick or too thin. The former will reduce the capacity, and the latter cause smoke.

Do not close the upper doors while fresh coal is on the fires.

Do not reduce the draft by closing the dampers, shutting the fire doors, or otherwise, except when absolutely necessary.

Keep the lower grates well covered, but do not let the bed get too thick, nor permit clinker to accumulate.

Keep the doors between the upper and lower grates closed, except when cleaning lower grates, say, two or three times a day.

Admit a small amount of air under the lower grates, except when they are bare immediately after cleaning.

When cleaning the upper grates see that none of the water tubes are uncovered or exposed. The quantity and location of clinkers can usually be determined by running the slice-bar through the fire. They can then be loosened and hooked out without seriously disturbing the fire-bed. It is better to watch for clinkers closely, and hook them out as fast as they are formed, rather than to attempt a general cleaning of the entire fire bed at one time.

Do not clean the lower grates when there is much green coal on the upper grates. Immediately after cleaning slice the upper grates carefully, so as to get a covering of live coals for the lower grates.

The ashpit should be cleaned as often as is necessary to keep it from filling up and obstructing the admission of air to the lower grates. Never clean the ashpit while the lower grates are bare or thinly covered.

Clean as quickly as possible, so as to avoid cooling the fires.

When cleaning the boilers see that the circulating pipes, and front and rear drums, to which the water grates are connected, are thoroughly washed out under pressure. Those parts which can be examined should be looked into at frequent intervals, and those which can be cleaned by mechanical means should have frequent attention. Where accessible, the water grates should be washed out by inserting a hose into each one.

THE PROXIMATE ANALYSIS OF COAL.*

By S. W. Parr, Professor of Applied Chemistry.

For the purposes of the engineer, especially in boiler tests and relative work, it is necessary to have the data to be obtained by a proximate analysis of the coal and ashes. This includes the determination of moisture, volatile products, fixed carbon or coke, and the ash.

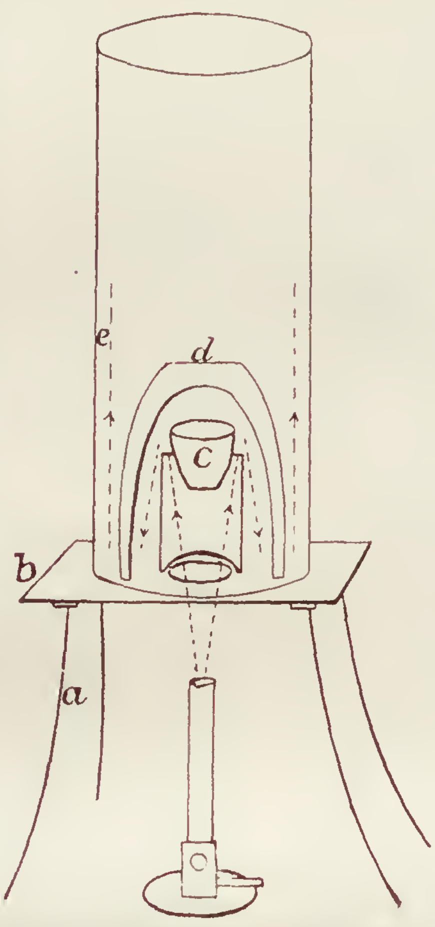
According to the standard methods, the following, in brief, is the outline of procedure: For the moisture, the finely ground sample is dried for one hour in an air bath at 105° to 110° C. For the other constituent, a fresh sample is taken, about a gram in quantity, and in a platinum crucible with the cover on, heated for three and one-half minutes over a Bunsen burner, and followed immediately with the highest temperature of the blast lamp for an equal length of time. The loss in weight, less the moisture obtained, equals the volatile combustible matter. The fixed carbon is next burned off by re-

* From *Technograph*, published by the Engineering Societies of the University of Illinois.

moving the crucible cover and heating in the flames of a Bunsen burner with access of air, till all the carbon is burned off. The loss of weight equals the carbon ; the residue is ash.

Owing to the cost of platinum and its rapid deterioration under the conditions imposed, as well as the impossibility of supplying platinum crucibles for extended class work, it became necessary to devise some substitute if possible, and make such modifications as would produce concordant results which conform to those obtainable by the regular method. It was thought that satisfactory results would be obtained with the ordinary porcelain crucibles, provided a sufficiently high temperature, corresponding to that obtained with the blast lamp and platinum crucible, could be reached.

To this end the principles of the Hempel furnace, shown in fig. 1, were adopted, as follows : *a* is an ordinary iron stand or tripod, and resting upon it is the plate *b*, about 10 or 11 American gauge in thickness with a 1½-in. hole in the centre. Over this hole is placed a sheet-iron or fire-clay cylinder or tube having three bearings at the upper edge upon which may rest the porcelain crucible *c*. Over this is inverted an ordinary assayer's crucible *d*, of such size and shape inside as shall allow of free circulation of the hot gases, and having sections cut away at the edge, so as to allow the escape of the gases, thus giving the inverted crucible three short legs on which to stand. Over all is placed the sheet-iron pipe *e*, about 18 in. in height and about 4 in. in diameter, depending somewhat on the size of the crucible *d*. The effect of this arrangement, as may readily be seen from the cut, is to compel the flame and hot gases from the Bunsen lamp to return upon themselves, and so heat the walls and surrounding parts as to prevent radiation away from, but rather direct it toward crucible *c*. The effect further of the chimney *e* is to make a draft and secure a good circulation, this making it easy with proper burner and gas supply to raise the crucible and contents to a heat quite equal to that obtained by the use of platinum and the blast. It should be noted, however, that much depends upon the character of the Bunsen flame. A triple burner giving flames that would reach to a height equal, say, to that of the top of the crucible *c*, proves perhaps the most satisfactory. With proper adjustment of such a burner it is easy to secure a white heat, and this should be accomplished if the results are to be trustworthy. In any event it is well to put the whole apparatus near the edge of the desk, so the crucible can be viewed from beneath and the flames regulated to suit the case.



COAL ANALYZING APPARATUS.

Two necessary variations from the standard method are at once obvious : First, the time element ; and, second, the reducing, rather than oxidizing atmosphere, for that part of the operation which burns off finally the fixed carbon.

For the first modification it was at first supposed that about double the usual time would produce the same distilling effect as the customary seven minutes with this platinum crucible, but that time gives results somewhat low, unless the parts of the furnace are well heated up before the crucible with the coal is inserted. Repeated experiments, in which time of heating was exactly fifteen minutes, were made and checked by parallel determinations in platinum in the ordinary way with quite satisfactory results, as indicated below. It should be noted especially, however, that the arrangement was such as to easily and readily give to the crucible a white or very bright red heat.

The second modification is necessary in burning off the fixed carbon. Here the use of the furnace is impossible, because an oxidizing atmosphere is essential. The complete Hempel arrangement of parts provides for the conducting into the crucible of a current of superheated air, and it was thought possible to effect the combustion by this means. A more satisfactory way, however, is to remove the outer parts and conduct directly into the crucible a slow current of oxygen from a glass tube of 2 or 3 centimetres internal diameter, or sufficiently large to avoid a jet of gas, the purpose being to avoid carrying away any light particles of ash.

The gas should pass through an ordinary wash bottle, so that its flow may be easily watched and regulated. This method of burning off the coke proves far more expeditious and satisfactory than the customary one of heating the platinum crucible in a current of air. Of course a good flame should strike the crucible, keeping it at a good red heat while the oxygen is being conducted into it, otherwise the process will be a long one. Occasional stirring may expedite matters, but care must be taken to avoid loss. Below are given some results obtained with comparisons by the standard method.

The column marked A gives percentages obtained by the usual method with platinum crucible and the blast lamp. Column B gives the results as obtained by the methods above described :

Coals.	Volatile Matter.		Fixed Carbon.		Ash.	
	A.	B.	A.	B.	A.	B.
Du Quoin	42.06	42.88	44 60	43.72	13 34	13.40
Odin lump	45.38	44.42	42 31	43.20	12.31	12.28
Moweaqua lump	44.17	44.41	42.01	41.62	13.74	13.97
Niantic nut	38.66	38.62	40.55	40.18	20.79	21.20
Odin ash*	15.27	16.52	....	....	...	...
Du Quoin ash	7.77	7.06	....	....	....	....
Moweaqua ash	8.36	8.29	....	. .	. .	...
Odin ash	14.69	15.01	....	....	....	....
Niantic ash	8.67	7.85	....	...	....	....

THE FUSE FOR THE PNEUMATIC DYNAMITE GUNS.

In previous issues of this paper† we have given descriptions of the pneumatic dynamite guns that have been erected at Sandy Hook, N. J., by the Pneumatic Torpedo and Construction Company for the United States Government, and the tests to which they have been subjected by the Ordnance Board. The wonderful accuracy that was obtained in the tests was a matter of surprise to all who had not carefully followed the development of the guns, and the fact that out of all the shots that were fired there was only one where the charge was not exploded, showed that the fuse was one to be most implicitly relied upon. The fuse and the firing-valve of the gun are the two details about which all of the interest in the mechanism centres. Our readers will recollect the intricacy in the construction of the valve, whereby the admission of the air is so nicely regulated that the impulse given to the projectile is adjusted to an absolute accuracy of range, and how, while the parts act in a prearranged succession, the time interval between the pulling of the firing-lever and the discharge is so short as to be practically inappreciable.

The same care that developed the valve is shown in the design of the fuse that is placed in the dynamite projectile. As in the mechanism of the gun, there were a number of problems to be solved in this connection also. In the first place, the fuse had to be of such a character that the projectile would be perfectly safe to handle after the fuse had been placed in position, and this means that it must be impossible for it to explode the charge. Again, there must not be the slightest danger of the fuse exploding the charge while it is in the gun, else the danger would be far greater to the gunners than to the enemy against whom operations were being conducted. Then, when it comes to the matter of actual explosion, the fuse must be in a condition to fire the charge almost immediately after it has left the gun, and must act upon impact, whether this takes place head-on against an unyielding body, such as the armored sides of a ship, or with a glancing blow, such as it might make against the face of a turret or the sloping curve of an armored deck or in a plunge into a yielding medium like the water. All of these conditions are fulfilled by the fuse under consideration, it being absolutely safe to handle, and exploding instantly upon impact against a rigid body and after a time interval when it strikes the water.

* Taken from the furnace of a boiler that was being tested.

† See American Engineer and Railroad Journal for September, 1894, and April, 1895.

The fuse is of the type known as the trigger fuse, and is inserted at the point of the projectile. The body of the fuse has a length of $11\frac{5}{8}$ in. from the end of the detonator to the top of the handle, and a diameter of $3\frac{3}{8}$ in. There is a narrow flange at the front end that is screwed up against the projectile, thus forming a bearing to hold the fuse in place. The handle *a* that is shown at the front end is screwed into the fuse, and serves as a cover, as well as affording a means of getting hold of the fuse for insertion and removal. At the rear end there is a brass case, *B*, $12\frac{3}{8}$ in. long and 3 in. in diameter, that is screwed into the inner end of the fuse and contains $2\frac{3}{4}$ lbs. of dry gun-cotton for the priming charge.

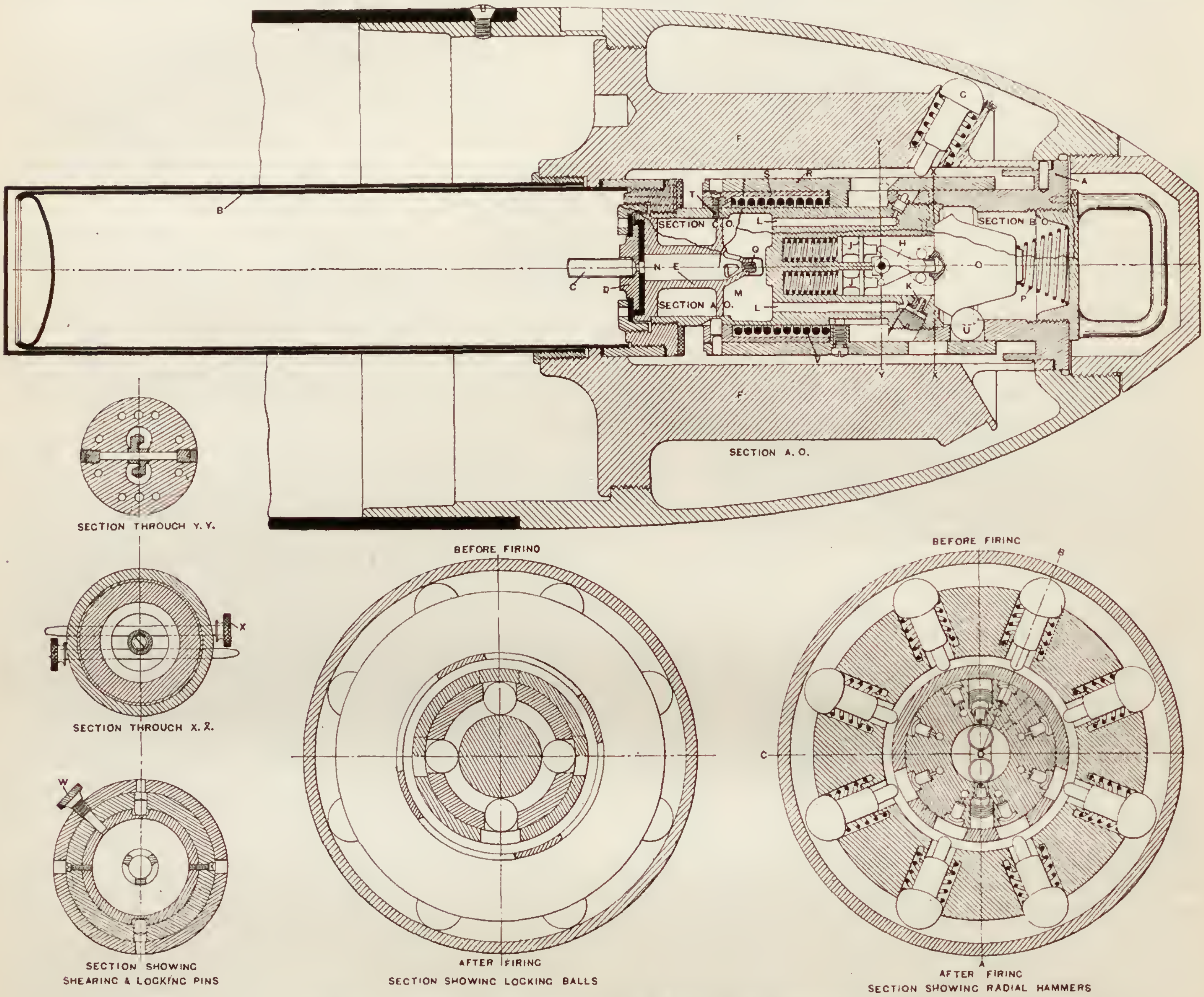
The detonator consists of the small copper cylinder *C*, $1\frac{1}{4}$ in. long, $\frac{3}{8}$ in. in diameter, and containing 37 grains of fulminate of mercury. It is held by being screwed into a brass washer, and extends into the dry gun-cotton charge. The washer *D*, holding this detonator, is clamped by a brass gland, *E*, between a vulcanite disk and a ring of the same material, in order to deaden any vibration. Fire is communicated to the fulminate through the small hole shown at the front end, and which is normally covered with a thin piece of shellaced paper.

An important *rôle* in the action of the fuse is played by the head of the projectile itself. It is made of cast bronze and $\frac{1}{4}$ in. thick. On the inside of the head there is a bronze casting, *F*, called the hammer-sleeve, which is secured to the head by a screw-thread. This hammer-head contains the fuse and carries eight radial hammers *G*, which stand at an angle of 60° with the axis of the projectile, and are pressed against the interior surface of the head by spiral springs, as shown in the engraving.

The head is made thin, so that it will crush in or collapse when the projectile strikes a solid object. The end of the hammer-sleeve *F*, which extends into the point of the projectile, is also made quite thin so that it will collapse under any blow that crushes the head. Finally, at the rear end of the fuse a copper protecting case is screwed into the hammer-sleeve, and thus protects the dry gun-cotton primer.

A better understanding of the action and construction of the fuse mechanism will be obtained by describing the apparatus and then showing its method of action. The explosion of the projectile when it strikes the water is accomplished by means of two spring-actuated hammers *H*, which strike caps and start time trains burning. The two spiral springs *I I* are placed in two circular cavities in the centre of the fuse. They have a force of 90 lbs. and press against circular piston-guides *J J*, that in turn press against the heels of the two hammers *H*. The hammers turn about a common pivot, like the blades of a pair of shears. When these hammers are thrown out they strike against two caps that are located on opposite sides in the interior of the fuse, and are indicated by *K*. Holes *L* are drilled from the nipples in which these are located, and are filled with a slow-burning powder composition. The powder composition is pressed into a brass tube having a length to give the desired delay, and this tube fits tightly into the channels, which are $\frac{3}{16}$ in. diameter holes *L* drilled in the body of the fuse parallel with its axis. From the time train fire is communicated to the detonator by a flash charge of flocculent dry cotton and of quick-burning rifle powder, these fill the two chambers *M* and *N* respectively between the detonator and the ends of the time trains.

Normally the two hammers are held from striking the caps by their ends entering a cavity in the face of a circular truncated metal piece, *O*, termed the trigger. This rests against a narrow circular seat, and is held in place by a conical spiral spring, *P*. Until the fuse is fired from the gun the trigger is positively locked in place by four steel balls. When these balls are removed the trigger is free to move forward and trip the hammers, when the projectile is retarded enough to cause the inertia of the trigger to overcome the force of the conical spring holding it in place; as, for example, when the projectile enters the water. By making this spring strong or



TRIGGER FUSE FOR USE WITH PNEUMATIC DYNAMITE GUNS.

weak the sensitiveness of the fuse can be adjusted within desired limits. The energy required to fire the caps is stored up in the two compressed springs I I, and the trigger has only to release this energy. In many earlier forms of fuses the blow of the ball or plunger, similar to this trigger, was used to fire the caps, and with heavy projectiles and a necessarily light ball a very considerable retardation of the projectile was required to fire the cap, and this could not be obtained in the case of projectiles striking the water at a low velocity. This, then, is considered to be the most novel feature of the fuse. Because it can be made so extremely sensitive it does not necessarily follow that it need be so, for by simply making the trigger spring very stiff it becomes very insensitive. Furthermore, it does not follow that because the fuse is sensitive it is dangerous to handle. Under all conditions of handling the trigger is positively locked, making it perfectly safe. Another feature of this hammer and trigger arrangement is the fact that it will operate no matter how the projectile strikes, even though it strikes on its side. This is due to the fact that the centre of gravity of the trigger is far in advance of its seat, and that the chamber in which it is contained is large enough to permit of a sufficient side movement to trip the hammers.

Should the projectile strike point blank against a solid object, the head will collapse and in turn collapse the fuse at this weak section, firing the cap Q, which communicates directly by a flash channel with the fulminate detonator, thus causing instantaneous explosion. The time trains would be ignited at the same time, but the projectile would explode before they could burn out

To provide for an explosion in the case of the projectile striking a glancing blow, there are eight firing-pins covering caps and in line with the eight hammers G held in the hammer-sleeve. Flash channels lead from each of these caps directly to the fulminate detonator. When the projectile strikes a glancing blow, a hammer will be driven against the firing-pins, either by the crushing of the head or by rebounding from the interior of the head, causing instantaneous explosion. The springs under the hammers are made sufficiently stiff to prevent the hammers from striking the firing-pins and causing an instantaneous explosion when the projectile strikes the water.

It will be readily seen from the foregoing that the fuse is in a condition to explode upon suitable provocation after the projectile has been fired, and it now remains to show how it is rendered perfectly safe to handle before firing. This is accomplished as follows: A sleeve, R, fits the outside of the fuse body and has a limited motion parallel with its axis. To prevent its revolving around the fuse, the point of a screw guides it by running in a slot. There are eight holes in this sleeve corresponding with the eight-side hammers G, and four holes corresponding with the four balls U that lock the trigger. Within this sleeve there is a shorter sleeve, S, and a stiff spiral spring, V, between the shoulders of the two tending to separate them. Before the projectile containing the fuse is discharged from the gun, the two sleeves are secured together by double pins with a joint in each. The sleeves are fastened to the body of the fuse by two small shearing screws. Before firing the long sleeve is in a position to cover the eight firing-pins, making it impossible for the side hammers to strike them, and in position to hold the four balls in place that lock the trigger. When the projectile is accelerated along the bore, both sleeves, after breaking the two shearing screws, move rearward against a babbitted seat. This rearward motion is about ⅜ in., and it causes the two jointed pins that have secured the sleeves together to be pushed outward by sliding up an inclined surface, until the joint in the pins coincides with the joint between the two sleeves, thus releasing all connection between them. So long as the projectile is being accelerated in the bore the sleeves remain in their rear position, but when the acceleration ceases, as the projectile leaves the muzzle, the outer sleeve is moved forward by the force of the spiral spring acting against the shoulder within it. Its motion is somewhat retarded by an air dash-pot into which its front end enters. It finally comes to rest in its forward position when the projectile has gotten well away from the gun. In this position the eight firing-pins are uncovered to the side hammers, and the four balls that lock the trigger are free to drop or be thrown out by the centrifugal force of the revolving projectile, thus unlocking the trigger.

In order to give additional safety in handling the fuse before it is inserted in the projectile, a screw, W, with a large milled head is put through both protecting sleeves into the body of the fuse, and two long pins X X, also having milled heads, are put through the fuse in a position to hold the hammers from striking the caps when the trigger is removed. The heads of this screw and the two long pins are so large that they must be removed before it is possible to enter the fuse into the projectile, thus making it impossible to leave them in the fuse by mistake.

The fuses are packed in hermetically sealed tin cases, and six placed in a wooden box lined with felt. A box of tools is also provided for charging, testing, and assembling the fuses.

The mechanism of this fuse, like that of the valve of the gun, was worked out by Captain Rapieff, who is the Chief Engineer of the Company, and the whole apparatus is a fine example of ingenuity and effectiveness.

WATER-TUBE BOILERS.

M. J. A. Normand, the well-known French engineer, recently read a paper on this subject before the Institution of Naval Architects, from which we make a few abstracts. He opened his paper with the frank acknowledgment that water-tube boilers are inferior to the ordinary marine type, in that any damage to any one tube necessitates drawing the fire and emptying the boiler, but claimed for them an immense advantage on account of their lightness and their capability of supporting an intense firing. This latter is limited by the formation of steam chambers or stationary steam, whereby the metal is apt to become overheated and rapidly corroded by the oxygen in the gases on the outside and the steam on the inside. Such conditions may, however, be avoided by having the direction of the tubes, especially at the lower end, as vertical as possible; by an active circulation; by having the proportion of length to diameter not too great, and by having the return section of the outside down-take of ample proportions.

In order to prove these propositions, a reference was made to the Du Temple boiler, shown in fig. 1. The oldest form of large boilers is shown at A, and the later at B, for the sake of clearness only one tube being shown in each. The heating surface of the two designs was kept the same by increasing the number of tubes in B.

Regarding the necessity of having the tubes in as nearly a vertical position as possible, it will be seen that an intense heat applied to the parts m m will produce steam which may take one of two courses: It may rise to the upper reservoir or go down to the lower one, or it may divide and go in both directions. In the first case, although the rise in the upper portions will produce a very energetic circulation, the resistance to an upward motion is very great, while in the second the resistance is small, as the pressure in the lower reservoir is always less than in the upper. When firing is slow the circulation may be in the right direction, but when the fires are forced or the vessel heels the contrary may be the case; for this reason the arrangement in B, where the angle with the horizontal is much greater, gives better results.

That the circulation should be very active is supported by laboratory experiments, by which it is shown that the coefficient of the transmission of heat varies from one to five, according as the motion of the water is *nil* or very great.

The section of the down-take should be large, because when the boiler is at work the pressure in the inferior reservoir is always less than in the upper. Should it be otherwise, the water would not flow by the return tubes. It is most probable that the steam generated in the heating tubes produces the circulation of water by impulse only. This force of impulse is so great, that when the tube is vertical, the ascending motion of the fluid may be estimated by applying the theory of communicating vessels, according to the difference between the mean density of the heterogeneous fluid in the heating tube and that of the water in the return tubes, due allowance being made, of course, for friction.

In this one thing is indisputable, and that is that the rise of water and steam in the heating tubes produces a difference of pressure between the upper and the lower reservoirs, and this difference reduces the intensity of the circulation. Accordingly it is of the utmost importance to lessen this difference by giving to the return tubes the greatest possible section.

The second cause which limits the intensity of the firing is the strains due to the expansion of the heating tubes, for the prevention of which there are several methods; but it is most important that there should be no joints or riveting in the actual vicinity of the furnace.

I have alluded already to laboratory experiments, according to which the coefficient of the transmission of heat varies from one to five, according as the water to be heated is quite stationary or in rapid motion. This is easily accounted for by this fact, that water is a very bad conductor of heat, and can be heated only by putting all the particles successively in contact with the heating surface. Although the actual conditions of a boiler are very different from those of the experiments, especially as regards the temperature of the heating

fluid, it is not less true that active circulation in boilers is most favorable to vaporization. This explains how the advantage to be derived from the use of feed heaters is always superior to that which results from the economy in the units of heat saved. This is especially to be noticed with Mr. Kirkaldy's feed heater. In this apparatus steam taken from the boiler heats the feed before its introduction into the boiler. The result is evidently to equalize, in a great measure, the temperature of the water and steam contained in the boiler with no apparent, though with an undeniable economy. The phenomenon may be explained as follows: When the water enters the heating tubes it travels without boiling through a certain length of those tubes; the lower its temperature is below that of the steam, the longer this distance; and, since the circulation is caused by the development of bubbles in the tubes, the intensity of the circulation is reduced as this difference of temperature increases.

For the last two years I have obtained the same result in the most simple manner by introducing the feed in the steam space under the form of spray, as far as possible from that part where the steam is taken for the engines. The feed being already heated by steam having done work in the high-pressure and medium-pressure cylinders, there is scarcely any difference of temperature between the water and the steam in the boiler. As soon as the water enters the heating tubes

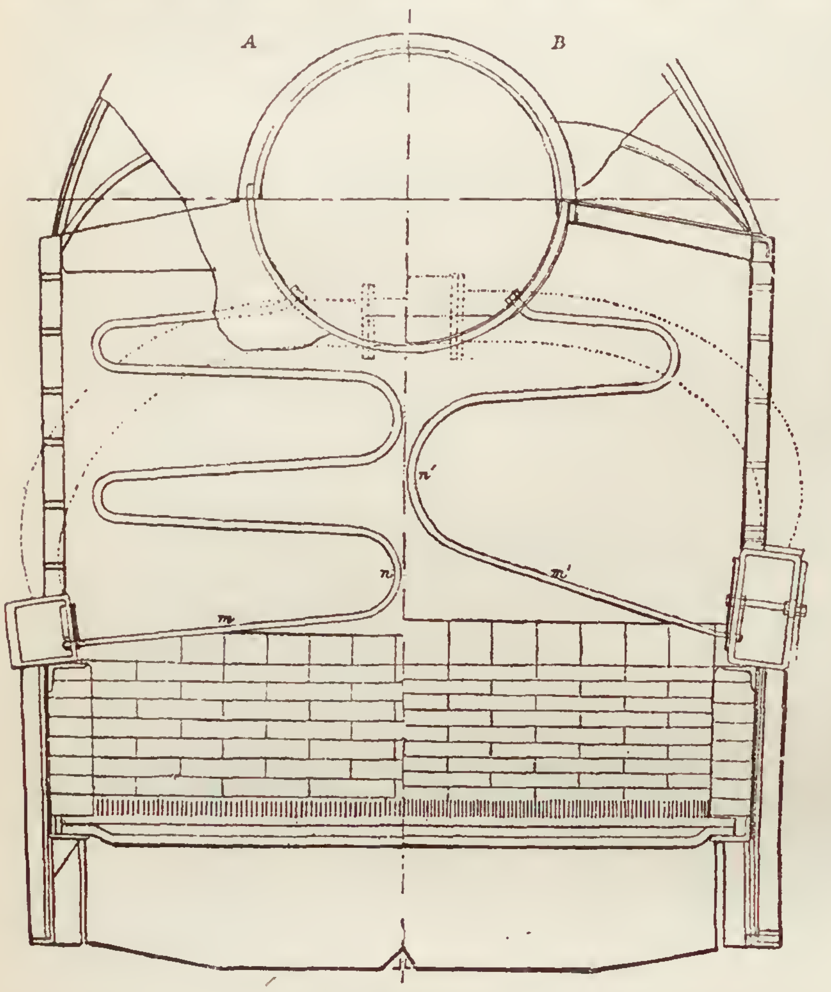


Fig. 1.

bubbles of steam are produced, and the circulation is increased to such a rate that the temperature of the tube is not higher than with cold feed. This mode of introducing the feed, which has the further advantage of depositing the calcareous salts in the form of powder, when using sea water, requires some very simple but particular arrangements in order to avoid shocks in the feed-pipes.

The temperature of the products of combustion would be enormous and greatly superior to that at which the dissociation of carbonic acid and steam takes place, if it could be completed in the fire-box. Starting from this undeniable fact, some engineers think that the heat should be progressively subtracted by cool surfaces during the combustion of the coal. This is certainly not the case. No cooling should take place during the combustion of petroleum, which cannot give its total heat unless it takes place in a white-hot refractory receiver, where it is impossible to avoid dissociation. The use of the brick arch in locomotive fire-boxes has proved equally advantageous for the complete combustion of coal, especially coal rich in hydrocarbons. For the same reasons it is most important to have high and large fire-boxes, where the hot gases are well mixed, and remain as long as possible before entering the cluster of tubes.

With a given capacity of boiler, the section of passage may be very great and the length of travel very small, or the section may be very small and the travel very long, with all intermediate proportions between these extreme limits. In the first case the draft is good, but the heating surface is very seldom thoroughly utilized. In the second case a good air pressure is necessary, but the economic duty is better, because the hot gases are obliged to heat the whole of the heating surface, and because the transmission of heat increases with the agitation of the gases, as it does in the case of water. This was proved a great many years ago by some most important trials made in France by Mr. Geffroy, of the Northern Railway of France, on a locomotive boiler. The evaporation was measured, first with all tubes open, and second with half the tubes only. In the last case, notwithstanding the enormous reduction of heating surface, the evaporation per pound of coal remained the same, with this difference only, that a greater air-pressure was necessary. The conclusion to be derived is that the section for the passages of the hot gases should be reduced, and their travel lengthened as much as is consistent with the draft available. The rules given above are certainly not the only ones necessary for making a good water-tube boiler, intended to resist intense firing, but they are certainly the most important. In order to avoid all misunderstanding, I will show how they have been applied in Normand's boiler. My intention is not to make known an apparatus that has already been many times tried in France and abroad, but I have chosen it because I believe it embodies more completely than any other the above principles.

In general appearance (see fig. 2) the boiler is the same as that used in 1893, but the arrangement of the clusters is new, and has been applied on the three torpedo-boats lately delivered. This arrangement gives a higher economic duty than the former one.

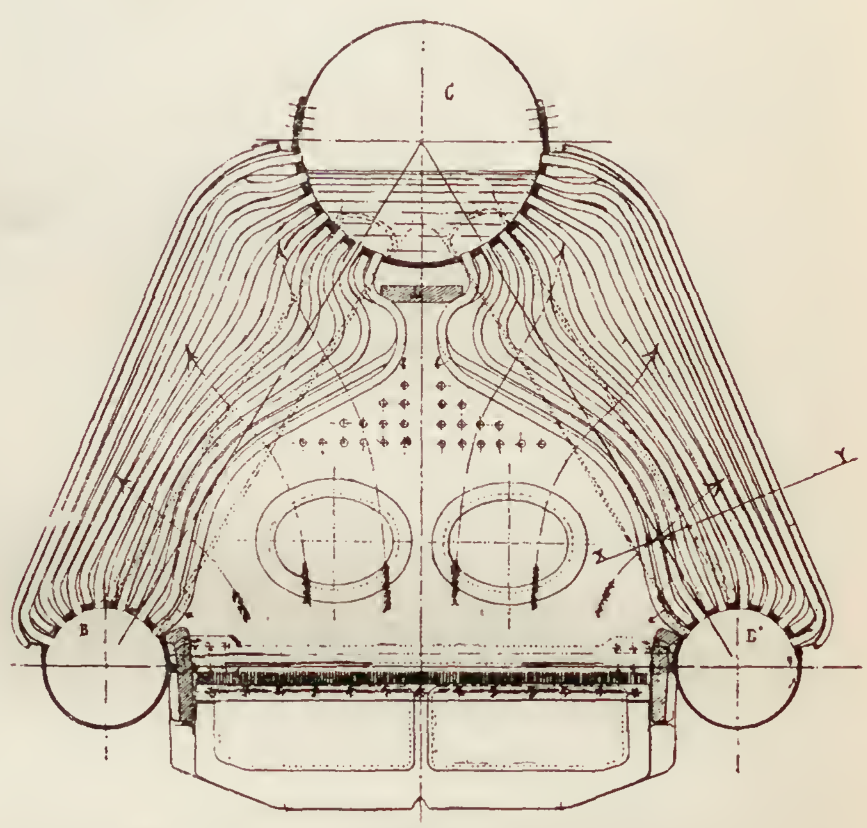


Fig. 2.

The particulars of the boiler are:

Grate surface	39 sq. ft.
Heating surface	1,840 sq ft.
Number of tubes	1 284
External diameter of tubes	$1\frac{3}{16}$ in.
Internal " " "	1 in. bare.
Pressure	299 lbs. per sq. in.
Weight with all valves, bricks, fittings, etc., without water	10 tons. 9 cwt.
Total weight with water	13 tons, 2 cwt.

In No. 185 (single screw) the power of the engine was measured and found to be, at the official full-speed trial, 1,680 I.H.P.

Air pressure	3½ in.
Consumption of coal per hour	2,600 lbs.
" " " " " per sq. ft. of grate	67 lbs.
" " " " " " indicated H. P	1.56 lbs.
Indicated H.P. per sq. ft. of fire grate	43 lbs.
" " " " " heating surface	0.91 lbs.
Mean temperature of feed	241° Fahr.
" " " gases in funnel	708° Fahr.

The fire bars were too close; more air will be admitted in future. At 14 knots the consumption of coal is under 1 lb. per I.H.P. per hour.

As indicated by arrows, the hot gases enter, on both sides of the boiler, the cluster of tubes L at the front end only, and through the whole height. They afterward travel horizontally to the other end where the funnel is situated. An in-

verted bridge, pierced with small holes, forces the gases to heat the lower part of the tubes before entering the funnel. Otherwise the upper part only would be heated. The general direction of the tubes, especially in the more heated part, is such that bubbles of steam will rise easily, and that none of the steam produced can return to the lower reservoirs. The height of the fire-box is very great, and the greater part of the flames and hot gases remain a long time in it, being obliged to come to the front before entering the cluster of tubes. The motion thus imparted to the flames is favorable to complete combustion. The ratio of length to inside diameter in the longer tubes is 68, whereas in the former type A, of Du Temple boiler, it was 160 and 320 in type B. The curves of the tubes are sufficient to prevent any undue strains from expansion. The diameter of the three return tubes is such that the difference of pressure between the upper and lower reservoirs must be very small. In boilers now building at my works, the return tube at the funnel end has been dispensed with. The section of passage of the hot gases is not so large that any part of the heating surface could be left out. Their length of travel is great, and their motion being perpendicular to the axis of the tubes, is favorable to their agitation, and consequently to the transmission of heat. On the other hand, it requires a higher air pressure. Should a better draft be found necessary, the width of the clusters of tubes might be increased.

The upper end of the tubes is under water, and the shape of the tubes is such that the formation of "steam chambers" is impossible. Water circulation begins as soon as the fire is lighted. It becomes intense at full power. When the vessel is laid up, the boiler may be completely filled with pure water saturated with lime. No air can remain in the tubes. This is of great importance as regards durability. It is indeed difficult to see why the firing could not be increased from what it was in the trial above mentioned if the tubes only are taken into account. From my own experience, it is the durability of the fire bars and bricks which limits the intensity of the fire.

Objections have been made about the necessity of removing several tubes should one middle tube be damaged. The quality of mild steel tubes is such that they may be taken out and replaced without the least difficulty. No better proof can be given of the feasibility of this plan than the following: The three boilers of Nos. 183, 184, and 185 were finished, when it was decided to alter the arrangement of the clusters, according to the new design. With very simple tools, hundreds of tubes were removed and replaced after having had their shape altered, without any of them being damaged.

Most of the principles laid down in this paper may appear to be so simple as to render their statement useless. It is not so, if we consider how very few of the different types of water-tube boilers are designed in accordance with all of them. However, my object is not to criticise any of these types, when not intended for intense firing, although the best boilers for intense firing are also generally the best for slow work. Many water-tube boilers are now making steam with tubes nearly horizontal, very low fire-boxes, great section of passage, and short length of travel. Each can boast of particular advantages which cannot be disputed. But the conditions imposed for boilers become more and more severe. In order to save weights, the combustion of fuel per square foot of grate increases every day; 20 lbs. is no longer sufficient, twice, perhaps three times as much will soon be expected for the most powerful engines. A good design will give the owner, the engineer, or the navy that adopts it a great advantage. It is worth while to examine how it will be possible to meet impending exigencies.

PERSONALS.

Mr. R. R. Hammond has been appointed Division Superintendent of the Kansas City, Fort Scott & Memphis Railroad, and will have charge of the division extending from Springfield to Mile Post 481 and also the Current River Railroad.

Mr. T. A. Miller has been appointed Assistant Superintendent of the Greenfield & Northern Railroad, which has recently been acquired by the Kansas City, Fort Scott & Memphis Railroad, and has been made a division of that road.

Mr. W. W. Fagan has withdrawn from the service of the Kansas City, Fort Scott & Memphis Railroad, and the office of General Superintendent has been discontinued.

Mr. J. H. Emmert has been appointed Superintendent of the Kansas City, Fort Scott & Memphis Railroad, and as such will have charge of all transportation, also of the repairs and maintenance of buildings, and the repairs and maintenance of road, track, and bridges under the general direction of the Chief Engineer. His office will be in Kansas City, and his authority will extend over the Kansas City, Clinton & Springfield Railway, the Current River Railroad, and the Greenfield & Northern Railroad.

OBITUARIES.

Alban Nelson Towne.

Alban Nelson Towne, Second Vice-President and General Manager of the Southern Pacific Company, died suddenly in San Francisco recently. Mr. Towne was born in Charlton, Mass., on May 26, 1829, and entered railway service in 1855 as a brakeman on the Chicago, Burlington & Quincy Railroad. He was advanced rapidly, and in 1867 was General Superintendent of the Chicago & Great Eastern Railway. He was subsequently appointed Assistant General Superintendent of the Chicago, Burlington & Quincy, but left that road in September, 1869, to become General Superintendent of the Central Pacific Railroad. He has since remained in the employ of the Huntington roads, and was elected to the position he filled at the time of his death on April 9, 1890. He married on September 25, 1850, Miss Caroline Amelia Mansfield, of Webster, Mass.

Henry Lefferts Brevoort.

Henry Lefferts Brevoort, a member of the old Brooklyn family of that name, died at his summer residence at Rockaway Beach on July 5, in his forty sixth year. He was the only son of J. Carson Brevoort and Elizabeth Dorothy Lefferts. The Brevoorts were descendants from an old Dutch family who settled on Long Island many years ago. They owned a farm there, which in late years has become part of the city of Brooklyn.

Mr. Brevoort was a man who inherited wealth, but to whom a life of idleness had no attraction. He early developed a fondness for mechanics, and before he was twenty-one years old he attended the Stevens Institute in Hoboken, and afterward formed a copartnership, and for a few years was engaged in machine business. He was of an inventive turn of mind, and brought out several new devices. Later he devoted himself to mechanical engineering, and was associated with Richard Buel, whose mysterious disappearance a few years ago was the cause of so much grief to his friends and relatives, and of whose fate no information was ever obtained. Later Mr. Brevoort became associated with his cousin, the late Henry Brevoort Renwick, a noted patent lawyer and expert. This relation led Mr. Brevoort to adopt the profession of a patent expert, in which he afterward acquired great distinction. Within the last twenty years few patent cases of importance were tried without his being retained by one party or the other. He was a prominent expert witness in such cases as the electric patent for telephony, phonographs, telegraphs, lamps, air-brake, and railroad machinery.

He was a member of the Union League Club of Brooklyn, a director in the Brevoort Savings Bank, and a member of a number of scientific societies.

Besides his professional acquirements he was a charming friend and companion, with a most attractive and genial character and manner, which made for him many friends, to whom his death is a sad loss, and a cause of sincere sorrow.

In 1883 he married Miss Gertrude Lefferts, a daughter of John Lefferts of Flatbush. She survives him. He also leaves three sons, John, Carson, and Henry. Mr. Brevoort was a member of the Church of the Pilgrims, and the Rev. Dr. R. S. Storrs officiated at his funeral.

Manufactures.

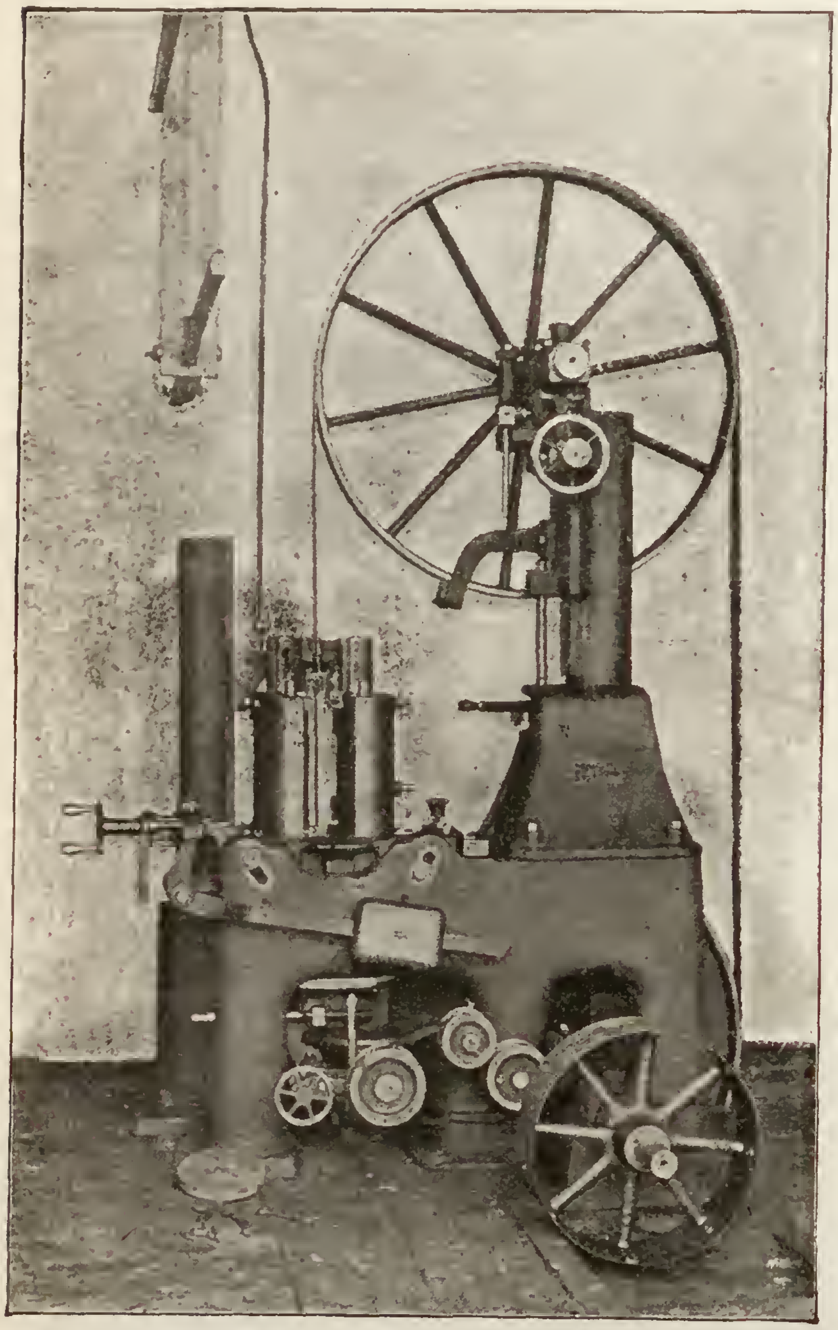
THE IDEAL RESAW.

With the destruction of our forests and the increased cost of timber in general, the item of waste, which was formerly entirely overlooked, has attracted a good deal of attention.

The workers in wood are now using machinery of improved patterns in all branches in order to manufacture as economically as possible, and one of the greatest economizers in wood-working is the band resaw. These have now become so perfect, that saws as thin as 26 gauge, or eighteen one thousandths of an inch in thickness, are actually used in sawing some classes of material, such as veneer, picture backing, and other thin

material, where the saw kerf would ordinarily constitute a large percentage of the timber worked.

W. B. Mershon & Company, of Saginaw, East Side, Mich.,



THE IDEAL RESAW.

owning one of the most extensive woodworking plants in the country, realized the necessity of a perfect resaw and designed the E. C. Mershon band resaws, one of which, the Ideal, is illustrated. Knowing what would be required of such a machine, they have provided all adjustments and attachments which are necessary, and in designing this resaw it has been with a view to using the thinnest saw possible. The saw blade on a machine of this description is the same as a main-spring of a watch, and the proportion of all the working parts has to be considered with reference to it.

In connection with the upper wheel all extra metal must be dispensed with, and the most sensitive cushions and springs provided for giving the right tension. The Ideal Resaw is so skilfully made that it is possible to manufacture from 1-in. timber four pieces which, after resawing, would measure in the aggregate $\frac{5}{8}$ in. This, as will be seen, leaves only $\frac{3}{8}$ in. for three saw kerfs and planing eight times.

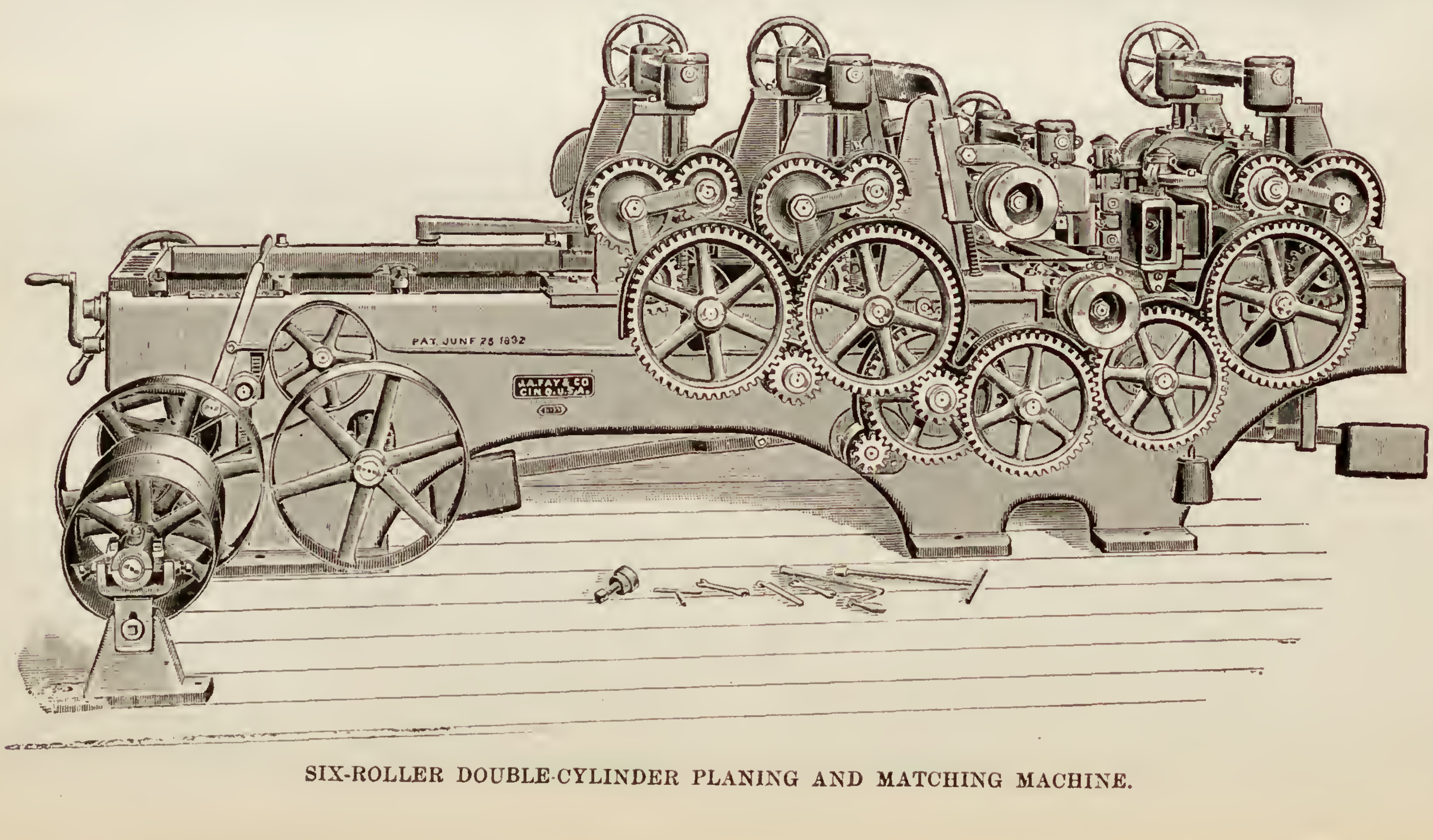
That these resaws represent wonderful advance in this line of work is evidenced by the fact that while they have only been on the market three years 100 of them are now in actual service. They are recognized as standard, not only in this country, but abroad.

NEW LARGE SIX ROLL DOUBLE-CYLINDER PLANING AND MATCHING MACHINE.

The machine shown in the accompanying illustration is the largest and heaviest planing and matching machine made by J. A. Fay & Co., Cincinnati, O., with special reference to durability, convenience, rapidity and the general requirements necessary to economy of labor and the superior quality of its productions. The machine is made in three sizes, to plane two sides up to 24 in., 28 in. and 30 in. wide and 10 in. thick, and match or joint material up to 18 in., 22 in. and 24 in. wide respectively.

The framing is massive and perfectly fitted and bolted together to secure the requisite solidity. The journals, shafts, gears, screws and bolts are made to standard sizes, and, with a system of interchangeable parts, enables duplicate parts to be supplied on short notice.

The cylinders are made from forged steel and are slotted on all four sides. The journals are $2\frac{7}{16}$ in. in diameter and are lead ground. The bearings are exceptionally long, and after being lined with the best material procurable, are scraped to a perfect fit. The upper cylinder has its bearings yoked together from above and planed to fit cored uprights cast to a solid bed plate and bedded in a groove which always retains them in line. These yoked bearings carry the pressure bar over the lower cylinder, which, while also having an independent adjustment, rises and falls with them. This pressure bar, after being set to suit the cut of the lower cylinder, requires no other adjustment for any variation in the thickness of the cut—an important item in a machine provided with a power-raising attachment. The lower cylinder runs in a



SIX-ROLLER DOUBLE-CYLINDER PLANING AND MATCHING MACHINE.

heavy frame, adjustable to suit the cut, and has pressure bars on each side of it.

The power-raising attachment is so arranged that the upper cylinder and feed rolls can be raised or lowered together, or that they may be instantly thrown out of gear and any desired adjustment made by hand. When the upright lever shown is thrown forward it unlocks the upper cylinder and tightens the belt operating the raising attachment, and another lever on the end girt, convenient to the operator, throws the friction in and out and raises or lowers the cylinder and rolls as the lever is thrown one way or the other. A gauge is placed on top of the side frame in a position to be easily read by the operator. Suitable stops are provided to prevent accidents arising from the cylinder and rolls travelling beyond a safe point. Ball bearings are placed under the upper cylinder screws, rendering them easy of adjustment by hand when desired.

The matching works are of the most substantial character. The arbors, of steel, $2\frac{3}{16}$ in. in diameter and $1\frac{15}{16}$ in. where the heads are applied, have each three bearings, one of which is placed at the top of the spindle, which can readily be removed for changing the heads by simply removing one bolt.

The weighted matcher clip with steel chip breaking lip—invaluable for working cross-grained or knotty lumber and producing rapid and accurate work—is hinged to the matcher hanger and a uniform pressure maintained by means of the weight. Regular matcher heads of gun metal with steel screws and patent solid milled matcher cutters or shimer matcher heads are furnished with the machine, as may be ordered.

To prevent shavings produced by the side cutter from being scattered over the machine, to the annoyance of the operator, shaving hoods are fitted to each hanger about the cutter heads, to direct all shavings away from the machine. These hoods are convenient in attaching exhaust pipes for the removal of the shavings by means of an exhaust fan. Pressure dogs are placed after the cut of the matcher heads to hold the material firmly while being matched. It is important to notice that the matching works are placed after the lower cylinder, the material thus being brought to an even thickness before being operated on by the side cutters.

The feed worms consist of six rolls 7 in. in diameter, and with large journals, one pair, placed after the matcher works, keeping the board in a straight line and feeding it entirely away from the machine. The feed rolls, mounted on planed upright stands, are fitted with socket joints and connected at each end by heavy expansion gearing with double or outside links, and are heavily weighted. The weighted levers are inside the machine and move with perfect freedom. The feed of the machine is very powerful, the rolls being large, and the belting, gearing and weighting being so proportioned as to allow no slipping. The front platen has two rollers in it to relieve the heavy timbers of friction, and this platen is arranged to admit of using the regular arm for holding the material against the guide, or a wooden lever as preferred.

Ordinarily two rates of feed are furnished with the machine, 41 ft. and 56 ft. per minute respectively; but other speeds are provided if desired.

Each machine weighs 15,000 lbs., and there is a shop number attached to it and a number on each casting to identify them, which should be mentioned in ordering supplies. The countershaft has tight and loose pulleys 16 in. $\times$ 10 in., and should make 1000 revolutions per minute.

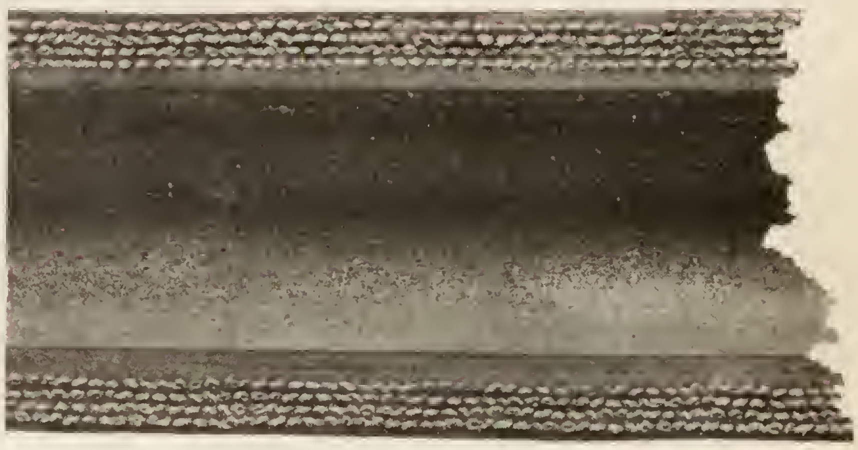
RUBBER HOSE.

In heating cars by steam and in the operation of air brakes, flexible hose is required to conduct the steam or compressed air from the engine to the train and from one car to the other. Experience very soon taught those who had charge of the heating apparatus and air brakes of railroad trains that the rubber hose which was used for that purpose deteriorated more or less rapidly from use. They also learned that there was very much difference in the durability of various kinds of hose, and that its lasting properties depended very much on the qualities of the materials of which it is made.

Hose for conducting steam and compressed air consists of several layers of heavy cotton canvas—usually four or five, as shown by the section herewith given—to give it the requisite strength. This canvas is covered inside and outside, and also between its layers, with a coating of vulcanized india-rubber to make it air or steam-tight. Both the canvas and the rubber must of course be flexible. The strength of the h se to resist internal pressure is dependent almost entirely upon that of the canvas used. If this has not the requisite strength, the hose is liable to burst. Its steam tightness—to coin a phrase—is dependent upon the coatings of rubber—chiefly upon that on the inside. This, too, must of course have great flexibility. While pure india-rubber, in its natural state, is very flexible, it has little power to resist heat, and very soon becomes softened when exposed to comparatively low temperatures. To give it heat-resisting properties it is vulcanized, as it is called—that is, it is mixed with mineral substances, chiefly sulphur. These alone have no flexibility, and are liable to crack and disintegrate when exposed to heat and constant flexure. In order that such hose may be durable, then, three things are requisite: (1) the canvas of which it is made must be strong enough; (2) there must be enough pure rubber in the internal and external lining to give it flexibility; (3) the rubber must be properly vulcanized to resist heat.

The most expensive material used in making hose is the pure rubber; the next is the canvas. There is, therefore, a constant temptation to manufacturers—under the stress of competition—to use as small a quantity of pure rubber as possible, and next to use a cheap or inferior quality of canvas. It may be said that the minerals which are compounded with the pure rubber have alone little capacity to resist heat and flexure combined. When subjected to both, they are speedily disintegrated. There is a proportion in which pure rubber and mineral substances may be combined which will give the maximum capacity to resist heat and flexure. As minerals are cheap and rubber is dear, the reader can judge which the manufacturer is most likely to add in excess. Under the stress of competition he is likely to add more and more mineral substances, or a cheap quality of rubber, to reduce cost, and rapid deterioration of the hose made of such materials follows.

Of course a great deal of skill and experience is required in the manufacture and compounding of the materials used in making rubber hose, but back of these a certain amount of integrity of purpose is of the utmost importance.



SECTION OF HOSE MADE BY THE PEERLESS RUBBER MANUFACTURING CO.

The practice of winding rubber hose with wire to protect it from abrasion and to fortify its strength is condemned by some manufacturers. The canvas alone, if of the right quality, should be sufficiently strong to resist any internal pressure to which the hose is subjected. When hose is exposed to the heat of steam the material of which it is made is softened and also expands. If it is wound with wire the hose cannot expand outwardly, and its movement must therefore be inward. The result is that the inside diameter of the hose is contracted.

The use of wire in wrapping hose is to be deplored, particularly if steam is employed, from the fact that hose, when conducting steam, softens at least 25 per cent., and it also has a tendency to expand the hose. It is a well-known fact that couplers require an exact length of hose on many of the roads, and the complaint is that their hose *grows* too short, which is owing to the expansion of the hose. Many of the manufacturers and railroad companies have decided to overcome this expansion by wrapping hose with wire. The result is that while the hose does not expand much and contract in length, it must move somewhere, so it goes in the only direction which is left—in other words, it swells the inside of the tube, eventually choking up the inside diameter of the hose completely.

Another effect is that when steam is passing through the hose both it and the wire are heateed, and the rubber is to some extent softened. When steam is turned off, the wire, being on the outside, and being a better conductor of heat then rubber or canvas, it becomes cooled first, and consequently contracts and is indented or pressed into the rubber. From the repetition of this disintegration occurs in time, and the hose is also chafed by the hard, unyielding material of the wire.

Another fact should be noted here, which is that the strength

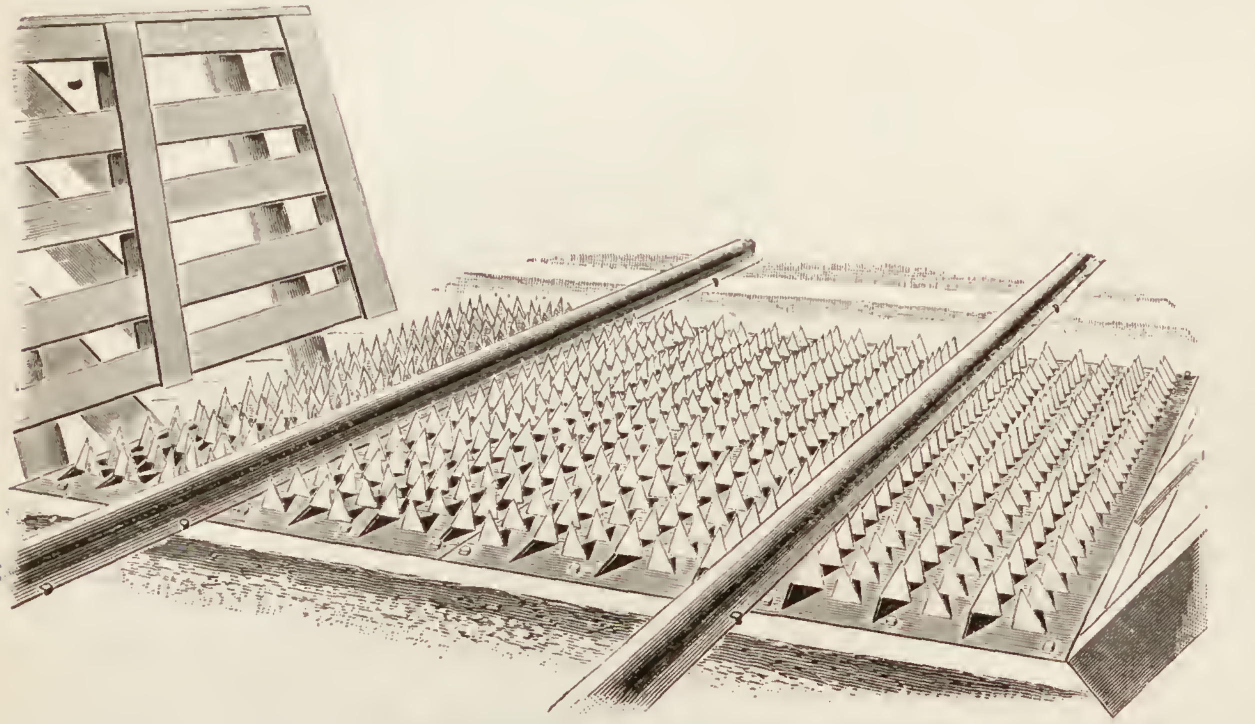
of hose to resist internal pressure is dependent chiefly upon the canvas of which it is made. This may be coated with a poor quality of rubber, which will soon crack and disintegrate, while the hose when new may resist a very great pressure. Of course all hose should be sufficiently strong to bear the pressure which it must resist, but beyond such limits its strength is not of much importance. For instance, if it is decided that air-brake hose should stand 700 lbs. per square inch, it would not add to its durability if it were capable of resisting from 900 lbs. to 1,200 lbs. pressure. Very streng hose may be coated with a very poor quality of rubber, and therefore would last only a short time.

In another part of the paper there are some illustrations given by the Peerless Rubber Manufacturing Company, showing the duration of some kinds of hose in service, and the deterioration of others under similar circumstances. These illustrations will give some idea of the difference in the quality of the materials of which hose is made. The notes under each engraving indicate the service of the different specimens, and also that in buying such material something else besides the price should be considered.

THE SHEFFIELD CATTLE-GUARD.

From the time that George Stephenson announced the fact to the parliamentary committee that a collision between a railway train and a cow would be very bad for the "coo," railway managers have adopted every precaution to prevent such collisions and the consequent damages that an unsympathizing jury would be sure to inflict when the case came to trial. At first the idea was prevalent that a hole in the ground would accomplish the purpose; but the notable cow that jumped over the moon seemed to have many descendants in the neighborhood of railway tracks, and the hole in the ground merely served the purpose of giving these animals a little healthy exercise, so that a desirable substitute had to be looked for.

In the next place, this hole in the ground was an undesirable feature in the landscape of the railroad and a continual expense to maintain. Something that could be laid upon the ground was the thing, and yet, at the same time, it must be of such a character that it could not be crossed by wandering cattle, while its durability must be such that the elements would have no effect upon it. These surface guards, as they are called, have had a large sale—so large, in fact, that they have entirely supplanted the holes in the ground, and the spirit of the roadmaster is now vexed by the necessity of making a choice. Our illustration shows a new candidate for the favors of the railroad buyers, and from an inspection of the engraving it would certainly seem that the way of transgressing cattle would be hard if they attempt to traverse this obstruction. It is formed of four sheets of steel boiler plate in which sharp teeth are stuck up very close together over the entire surface, presenting an area that reminds one of the hard road to travel—so hard, in fact, as to be about impassable. As brevity is the soul of wit, so simplicity is the soul of a successful mechanism, and here this seems to obtain. There are no rods or bars to be broken or displaced and the track needs no preparation whatever in order that it may be put in place. It cannot fail to be durable, and its weight is a warrant that it will make no noise when a train passes over it. The standard style is furnished with a coating of asphaltum paint, or the sheet may be galvanized, as the purchaser may prefer.



THE SHEFFIELD CATTLE-GUARD.

It is made by the Sheffield Car Company, of Three Rivers, Mich., and has already been adopted by a number of railroads as their standard cattle-guard.

TEST OF A RICHMOND LOCOMOTIVE WORKS COMPOUND ENGINE ON THE ROCK ISLAND RAILROAD.

The following interesting report of the performance of a 10-wheeled compound, in comparison with a 10-wheeled freight locomotive on the Chicago, Rock Island & Pacific Railroad, has been received from the Richmond Locomotive Works. If a saving of 25.4 per cent. of fuel can be maintained, without any increased expense in other directions, the case for compound locomotives is proved. The report contained in the tabular statement was furnished by Mr. George F. Wilson, Superintendent of Motive Power and Machinery of the line referred to.

ENGINE TEST—10-WHEELED ENGINES.

Illinois Division of Chicago, Rock Island, and Pacific Railway.

Richmond Compound, No. 2427. Cylinders, 19" and 30" × 24"; Driving-Wheels, 62" diam.; Condition, out of Shop 9 Months.						Rock Island Simple, No. 808. Cylinders, 19" × 24"; Driving-Wheels, 62" diam.; Condition, just out of Shop.					
Date.	Number of 100-Ton Miles.	Lbs. of Coal Used.	Lbs. of Coal per 100-Ton Miles.	Ounces Coal per Ton Mile.	Actual Running Time.	Date.	Number of 100-Ton Miles.	Lbs. of Coal Used.	Lbs. of Coal per 100-Ton Miles.	Ounces Coal per Ton Mile.	Actual Running Time.
June 17	2,152.50	16.770	7.70	1.232	8.20	June 18	2,104.78	25.800	12.25	1.960	8.36
" 20	1,834.74	15 400	8.39	1.342	6.50	" 19	1,696.08	20.000	11.80	1.889	8.10
" 23	1,884.54	15.900	8.43	1.349	7.25	" 22	1,608.89	15 950	9.92	1.587	7 20
" 25	1,788.62	16.880	9.43	1.509	6.30	" 23	1,776 64	17.600	9.90	1 584	6.55
" 26	2,193 25	18.030	8.22	1.315	7.45	" 24	1,932.67	21.400	11.07	1.771	8 31
" 28	2,068.33	16 000	7.73	1.237	7.20	" 26	1,365.45	15.850	11.60	1.856	5.45
" 30	2,065.80	16 350	7.91	1.265	7.20						

Average lbs. of coal per 100-ton miles	Richmond Compound	8 27	Saving for Compound, 25.4 per cent.
	Rock Island Simple	11.09	

AERONAUTICS.

UNDER this heading we shall hereafter publish all matter relating to the interesting subject of Aerial Navigation, a branch of engineering which is rapidly increasing in general interest. Mr. O. Chanute, C.E., of Chicago, has consented to act as Associate Editor for this department, and will be a frequent contributor to it.

Readers of this department are requested to send the names and addresses of persons interested in the subject of Aeronautics to the publisher of THE AMERICAN ENGINEER.

SPEED IN MIGRATORY FLIGHT OF BIRDS.

By KARL MILLA.

WE condense from the Proceedings of the Ornithological Society of Vienna, the following report of an interesting lecture delivered before that Society on the 31st of January, 1895, by Herr Karl Milla, of Vienna, a well-known aviator and author, who was also the Secretary of the Aeronautical Society of Vienna (Anstria.) The foot-notes have been added by the present editor.

THERE appeared some years ago a book by Henrick Gätke, entitled "The Bird Refuge of Heligoland," in which the author recorded his very valuable experience and observations upon the doings and life of birds, collected during fifty years on the lonely island of Heligoland.*

In this book Gätke makes some statements concerning the speed of birds in migration, which appear so remarkable that they probably aroused a great deal of incredulity. I, too, felt somewhat startled, and as I have busied myself for years with this question of bird flight, I may now venture a contribution on this subject, one of the most difficult problems to be found in nature.

According to Gätke's observations, concerning the accuracy of which there can now be no doubt, the "gray crow" flies over the North Sea, a distance of 80 German geographical miles (each 4.61 English land miles) in three hours, which is equivalent to a speed of 55¼ metres per second (124 miles per hour); and yet this bird, as is well known, does not belong to those most expert in flight. Nor does a singing bird, like the northern "blue neck," belong among the best fliers; and yet, according to Gätke, it develops a speed of 45 German geographical miles per hour, or of 92 metres per second (205 miles per hour). The highest speed of all is found, on the authority of the same veteran observer of Heligoland, in the "Virginia rain-piper." This bird covers the enormous stretch, from Labrador to Northern Brazil—that is to say, 800 German geographical miles—in a single flight of 15 hours. This would be equivalent to a speed of 109 metres per second—253 miles per hour—a velocity almost monstrous.†

The result of his observations and conclusions force Gätke to make the following statement (page 74 of his book): "The proven speed of flight in the 'Virginia rain-piper' is so very great that we are forced to the conclusion that it is made possible only by some other means beside the mechanical apparatus with which the bird is equipped."

As a matter of fact, such calculations as have been made concerning the speed which birds attain, by means of their mechanical appliances alone, indicate that those speeds are far less than those observed by Gätke. Let us take, for instance, one of the better fliers, a 'mouse-buzzard' (kite). One of these, measured by myself, weighed 0.927 kilogrammes (2.04 lbs.), and spread a total supporting surface of 0.2469 sq. metres (2.65 sq. ft.), a ratio of 1.3 sq. ft. per pound. It should be noted that not only the wings, but the tail and underside of the body, help in carrying the weight, and that all these parts are included in the above area.

The law of air support, which we know to-day with some accuracy, and will use to determine the velocity of flight, may be expressed by the following formula:

$$P = a \times 0.13 \times F \times v^2,$$

* Heligoland is a rock 200 ft. high and about 5½ sq.m. in area, in the North Sea, off the mouth of the river Elbe. It lies nearly in the track of one of the main migrating routes of the littoral for birds, proceeding from the Baltic to France and Italy, or *vice versa.*

† The lecturer does not state how these speeds were ascertained, and in view of their extraordinary character, communications are invited from naturalists and others having knowledge of similar performances by birds.

in which P is the lifting power of the air, which in calm air is produced by the motion of the bird, and is equal to its weight.

v is the velocity in metres per second;

a is a variable coefficient, which lies betwen $\frac{2}{5}$ and 1, according to the angle of the wing;

F is the carrying area as defined above.

The above coefficient a is the result of the investigations of Otto Lilienthal upon concave surfaces, such as birds' wings. The present lecturer has discussed its application to the phenomena of bird flight in his book, "The Flying Motions of Birds," Leipsic and Vienna, 1895.

Suppose now the most favorable case—*i.e.*, an exact horizontal position of the wings, at which we presume the bird will be able to fly with the least expenditure of work. The coefficient, according to Lilienthal, will then be about $\frac{2}{5}$, and we have for the velocity required for support:

$$P = 0.4 \times 0.13 \times 0.2469 \times v^2, \text{ but } P = 0.927 \text{ kg.};$$

$$\text{hence,} \quad v = \sqrt{\frac{0.927}{0.4 \times 0.13 \times 0.2469}} = 8.5 \text{ metres,}$$

or 19 miles an hour, at which velocity the "mouse-buzzard" is just able to sustain himself.

It is to be noted further that, to a certain extent, the smaller are the birds, the larger are their wing surface in proportion. It follows from this that small birds can be supported at less speed of flight than larger birds. I give calculations for two extreme cases.

A house swallow, with a weight of 16.4 grammes (0.036 lbs.) and an area of 113 sq. centimetres (0.121 sq. ft.), would need under the same conditions as above stated for the "mouse-buzzard" a speed of but 5¼ metres per second (11.7 miles an hour) for support; while, on the other hand, a heavy bird, like the albatross, which weighed 12.7 kilogrammes (28 lbs.) and measured 1.78 sq. metres (19.15 sq. ft.) of supporting surface, requires more than twice the above velocity, or 11.7 metres per second; say, 26 miles per hour.*

Now, these calculated velocities are very small when compared with the bird velocities already given as the result of observations. The discrepancy cannot be bridged over even by doubling the above computed speeds, and I therefore agree with the watchman on the parapet of the Heligoland bird rest, when he says that some other power besides the muscular force of the birds must be acting, if it prove quite true that the real velocities of bird flight are not a paltry 8½ — 5¼, or 12 metres per second (19.12, or 26 miles per hour), but are more than 100 metres per second, or 223 miles an hour.

But I disagree with him in his opinion that these high velocities are accounted for by the decreased density of the higher strata of air in which the migration of birds usually takes place.† He says, on page 75 of his book: "In treating of the height at which birds fly when migrating, the fact has been explained more in detail that birds alone, among warm-blooded animals, are provided with a respiratory apparatus which enables them to remain a long time in thin strata of air, containing but little oxygen, even as high up as 40,000 ft. above the sea, and that they are equipped with a very complete system of air sacs, which they are able to fill or to empty at will. Those organs have no use at all apparent in the every-day life of the bird; still they must serve some purpose. This purpose may be solely in making possible these truly wonderful migratory flights; wonderful in the great height and speed at which they are carried out. If the birds during their fall and spring migrations were limited to the same lower air strata in which they move during the rest of the year, many of them would be hindered from carrying out their journeys in consequence of storms. For this reason they rise to greater heights, which are usually less subject to

* These velocities are probably underestimated; first, because the lecturer has made no account of the difference in the shape of wings of various birds, that of the swallow being notably flat in action, and second, because he has applied to the *whole* surface, part of which is convex, the coefficients obtained by Lilienthal upon concave arched wings alone. These considerations, with the further point that the horizontal position may not be that of minimum work, may increase the computed speed by 50 per cent., but this in no way invalidates the subsequent argument of the lecturer.

† Marey, in "Le Vol des Oiseaux," page 36, quotes the following velocities as given by Jackson:

Quail,	38	miles	per	hour;
Pigeon,	60	"	"	"
Falcon,	63	"	"	"
Eagle,	69	"	"	"
Swallow,	150	"	"	"
Martin,	200	"	"	"

These are presumably near the surface of the earth.

violent changes in the direction and turmoil of the wind. They also reach heights at which the decreased resistance of the lighter air makes possible their remarkable increase in speed, which yet counteracts the tendency to fall, as a very slight raising of the forward edge of the wing restores the required support.

"Through these considerations, the proven speed of migratory flight is not only more easily understood, but its existence may even be considered as demonstrated"

I must emphatically contradict this view. All the more as it has been adopted by others. Thus W. Berdrow (*Prometheus*, 1894, page 229) not only agrees with Gätke, but even goes further and says: "In this way—*i.e.*, by flying at great heights, according to the wonderful laws of air resistances, the work necessary may easily diminish to one-tenth or even one-twentieth of that necessary at the surface of the earth."

Now, in the first place, it is not proven that migrating birds really do fly at such enormous heights as 40,000 ft. above the sea.* Gätke, it is true, estimates it at this height, but we should consider two things: 1. An estimate is not a measurement, and such measurement is most difficult even when near the earth in transparent air; and 2. The mere vanishing of the bird to the eye of the observer is no proof against mistakes, as we may expect differences to intervene in the moisture, and therefore in the transparency of the different strata.

But even granting that the birds are able to fly at these enormous heights, still "the wonderful laws of air resistances" actually prove that the difference in the density of the air is not sufficient to account for the great speeds in question. The simple consideration that the thin upper air must still carry the *entire weight* of the bird, readily shows that the work done by the creature cannot be much less than that in denser strata.

Let us consider this theoretically. The work we assume to be the same in both cases, hence

$$A = a\frac{B}{g}F v^3 = a\frac{b}{g}F V^3.$$

This is the law for any resisting medium.

A in metres kilogrammes depends upon the coefficient a, which is a function of the form and sharpness of the flying body, but not of the density of the air, and which may therefore be left out of the above equation.

B and b are the weight of a cubic metre of air in the denser and in the thinner strata respectively.

F is also a constant for the same bird; its surface.

V and v enter into the equation in the third power.

g is the usual coefficient of gravity.

From the above equation we have:

$$B v^3 = b V^3, \text{ or } V = v\sqrt[3]{\frac{B}{b}};$$

or, to put it in words, the velocity in the thin stratum is to the velocity in the thick stratum as the cube root of the ratio between the respective densities is to unity.

For instance, assume a height of 20,000 ft., or 6,096 metres (about the height of Chimborazo); then the air pressure, equivalent to 365.2 millimetres of mercury, gives $b = 0.5968$ kilometres per cubic metre, if we suppose the temperature —10° C. with 50 per cent. moisture. At sea-level $B = 1.2936$ kilometres per cubic metre, barometer = 760 millimetres; hence we have

$$\frac{V}{v} = \sqrt[3]{\frac{1.2936}{0.5968}}, \text{ or } V = 1.2942\,v,$$

so that if a bird can fly 100 kilometres per hour in the lower and denser air, it will cover 129 kilometres per hour at the upper level, assuming that the work done is the same.

If we assume, with Gätke, a bird flying at a height of 40,000 ft.—that is, 12,192 metres above sea-level—the barometer at that height would stand at 141.6 millimetre, and the weight of a cubic metre of air would only be 0.265 kilogrammes. In this case the same formula gives $V = 1.6962\,v$—that is, the bird would fly about 170 kilometres per hour instead of 100 kilometres at sea-level.

From these figures it follows that the decreased density of the air does not explain the great speed obtained in the migratory flight of birds, nor the small amount of work which seems to be expended by them; so we must seek for some other cause.

Now there is another factor which accounts for these speeds—namely, the wind.

Gätke himself remarks (page 96) that "birds during their semi-annual migrations prefer to start in an easterly and southeasterly wind, even when gentle." He also quotes an observer in England, John Cordeaux, to the effect that on the east cost of Scotland, opposite to the island of Heligoland, the birds appear in large numbers when the winds are easterly and southeasterly; while but few birds arrive with the contrary winds; and that in the latter case these few birds probably flew very high.

Reasoning from this fact, determined by both observers, and from the further fact that if the bird be travelling in the same direction as the wind, it must have an additional speed of its own in order to obtain support, inasmuch as this is derived from a current passing its wings from front to back, it seems clear that if the wind be blowing at the rate of 40 metres per second (89 miles an hour), and the bird is rowing at the rate of 10 metres a second (22 miles an hour) in the same direction, it will actually travel 50 metres per second, or 111 miles per hour.

It now becomes a question whether the wind can reach such great velocities as are here assumed. Upon this point the observations of wind velocities made at the Eiffel Tower leave little doubt, as the speed is found to increase with the altitude, and on December 20, 1893, a velocity of 44 metres per second (98 miles an hour) was observed at the top.

Aeronauts have measured velocities of even 52 metres per second (116 miles an hour),* and have generally stated that the higher up they went the faster they travelled, so that we may assume as reasonably certain that at high altitudes (though we do not mean by this heights of 20,000 ft. to 40,000 ft. above the sea) great velocities do frequently occur.

As we know by the valuable observations of Gätke that birds are gifted with a very delicate premonition of changes in the weather, and further, that they frequently postpone their departure,† we may conclude that they are simply waiting for the right weather for their journey, and that they select the strata of air which move with the greatest velocity in approximately the right direction, in order to reach the end of their voyage in the quickest and surest way.

Inasmuch as the real speed of various birds is very hard to measure and very little known, save for carrier pigeons, whose velocity in still air is about 60 miles an hour, we cannot now say what is the normal speed of the migrating birds which have been above mentioned in the lower strata of the atmosphere; but as the work required for flight grows rapidly, or as the cube of the velocity, we cannot reckon upon any material increase of their speed obtained by a greater expenditure of muscular energy in the upper strata of air. Still less can "a slight lifting of the upper edge of the wing counteract the tendency to fall," as Gätke suggests. On the contrary, we know by the laws of flight that this apparently slight lifting lies heavy on the balance in a long-continued journey, because it increases the work to be done, while it decreases the speed of motion. It is the increased speed, without any change in the angle of incidence of the wing, which not only prevents sinking, but makes the flight possible with comparatively small expenditure of energy.

All considerations thus bring us to the conclusion that the skilful utilization of the force of the wind must be the only and sufficient extraneous means employed by the feathered wanderer to achieve the wonderfully fast flights which have been observed; and even if, by my explanations, I have succeeded in clearing up somewhat the obscurity surrounding this phenomenon, the performance still remains, and will continue to remain, a truly wonderful achievement, full of promise for the time when man shall learn to imitate the birds.

AN AERIAL YACHT.

Recent French newspapers state that a navigable pleasure balloon is now under construction for Mr. E——, a well-known and learned archæologist and numismatologist, who proposes to utilize it for aerial trips upon pleasant days when there is little wind.

* The height of migratory flight is usually estimated at one or two miles by naturalists. The condor soars perfectly well at a height of two miles above the sea in the Andes.

* The following are the speeds of a few balloon journeys:
1810. Garnerin, 36 metres, or 80 miles an hour.
1850. Green, in the *Nassau*, 64 metres, or 143 miles an hour.
1868. Fonvielle and Tissandier, 35 leagues, or 105 miles an hour.
1870. "General Chanzy," 129 kilometres, or 79 miles an hour.

† It is not uncommon for migrating soaring birds to mount high in the air by circling, and then to circle down again to the point of departure; repeating this sometimes several days in succession, until, the circumstances aloft having apparently become favorable, they are off upon their course.

The designs have been made by Mr. H. de Graffigny, the well-known aeronaut, and are interesting as indicating the best modern practice.

This yacht is to carry two persons, and to achieve a speed of 19 miles an hour in still air. It is to be of elongated shape, 98 ft. long and 22½ ft. in diameter at the greatest section, being thus in the proportion of 4.35 to 1. In shape it consists of a section of a cone 39 ft. long, with ellipsoids of revolution at each end. The skin consists of strong cotton cloth, with an ultimate resistance of 700 lbs. per lineal foot on the woof, varnished with four coats, and weighing 0 06 lbs. per square foot. The total surface of this long spindle is 613 sq. ft., and it is to contain 26,500 cub. ft. of hydrogen gas, with a theoretical lifting power of 0.074 lbs. per cubic foot. There is to be the usual valve at the top, and an "appendix" or relief sleeve at the bottom, but no interior air bag, as the trips are to be short.

The car is to be suspended by a "saddle-cloth" fitting the upper half of the balloon closely, instead of the ordinary netting. This "saddle-cloth," made of 270 sq. ft. of the same material as the balloon, but not varnished, is substituted for the purpose of obtaining a uniform distribution of the weight, and of diminishing the friction of the air. Its lower end is provided with a hem, into which small wooden rods are inserted. Eyelet-holes in the hem admit of inserting the suspension cords for the reducing meshes, the strains being thus equalized upon the "saddle-cloth" through the rods, and any pitching effects due to movements of the gas in the balloon distributed lengthways.

The car consists of a frame of wood and rattan, with woven wicker panels and a wooden floor. It is 13 ft. long and 3¼ ft. wide. At the front and at the rear there is an extension pole 16 to 20 ft. long, securely fastened to the car, which thus is lengthened out to 45 or 50 ft., and provided with a sort of keel. To this keel are attached the 36 suspension cords descending from the lower extremity of the "saddle-cloth," and it, moreover, supports the shaft which actuates the propelling screw, as well as the pivot for the rudder. The whole system is stayed by diagonal ties, and the keel is, moreover, connected by lines to short sections of netting fastened to the nose and rear end of the balloon.

The weights are to be approximately as follows :

Balloon, 613 sq. ft.	352 lbs.
Saddle cloth, 270 sq. ft.	75 "
Valve and appendix	26 "
Cords, ties, etc	44 "
Poles and fastenings	53 "
Car complete	44 "
Anchor, guide rope, etc	66 "
Total	660 lbs.

Allowing for impurities in the gas, and a consequent lifting power reduced to 0.066 lbs. per cub. ft., the balloon can sustain 1,750 lbs., or 1,090 lbs. more than its own weight, which surplus may be utilized as follows :

Aeronaut	143 lbs.
Passenger	165 "
Ballast	176 "
Motor, etc	616 "
	1,090 lbs.
Weight of balloon	660 "
Total lift	1,750 "

Thus it is seen that the possible weight of the motor, including its supplies of fuel, etc., for a trip is limited to 616 lbs. Inasmuch as the resistance of the largest section, of 398 sq. ft. area, is estimated at 77 lbs., at a speed of 19 miles per hour, it is calculated that the energy required is 4 H.P. upon the screw-shaft, or 8 H.P. at the engine, after allowing for losses. This therefore limits the motor alone to a weight of about 61 lbs per H.P. exerted. This problem is said to have been solved, although, pending the issuance of some patents, no indications are given as to the kind of motor adopted, save that it can develop 10 H.P. for two and one-half hours, and rotate a screw of 37 sq. ft. area at 90 turns per minute.

The whole apparatus is expected to be completed in August, 1895, and accounts are promised of the results attained on its trial trip.

A NEW AIR PROPELLER.

A late issue of the Paris *Gaulois* states that the committee on new inventions of the French Ministry of War is looking into the merits of a new form of aerial propeller for balloons, which is said to be novel and effective.

The novelty is stated to consist in the abandonment of the screw principle, which experiment has hitherto failed to improve, substituting therefor a system of vanes, both light and powerful, which is claimed to result in greater normal air pressure.

The new propeller is said to exert a thrust upon the air of 87 lbs. per H.P., while the screw has hitherto given but about half of this thrust ; thus reversing the experience which has hitherto obtained with rotating vanes, the latter having always been found decidedly inferior to the screw.

Experiments would already have taken place at Meudon, had not the inventor, who lives at Limoges, refused to communicate his plans to the Ministry of War. He says the commission must come to him if it wishes to be convinced.

AERIAL ADVERTISING.

Professor Carl Myers, the well known aeronaut, resides near Frankfort, N. Y., on what he calls his "balloon farm," and here he collects and manufactures the apparatus used by him in his ascensions, and also makes balloons and other aeronautical apparatus to order.

Recently the introduction of the life-saving balloons for conveying lines from wrecked vessels to shore caused worldwide notice, and no later than last week Professor Myers had orders for an outfit from Russia. Now he has been giving his attention to the production of balloons for advertising purposes.

The outfit for this purpose consists of a portable hydrogen gas generator of a type patented and in use by Professor Myers during several years, in connection with a light captive balloon capable of raising a variety of matter for advertising purposes. A balloon of this kind, 12 ft. in diameter, was completed recently, and bore on two opposite sides the words Columbia Bicycles, in huge letters of dark blue, the colors of that 'cycle. This, held captive at a height of 400 ft., made a conspicuous mark in the sky.

The entire outfit was built especially for the Pope Manufacturing Company, of Hartford, Conn., and was shipped Monday to Asbury Park, N. J., to be exhibited there during the bicycle parade. A bicycle glittering in nickel and aluminum was to be suspended from it, and the use of this "sky-bicycle" will be made regularly in bulletining events of the field as they occur ; so that any notable result, world record-breaking or prizes captured, may be almost instantly communicated by placards to tens of thousands of people, widely spread over the entire section. This is "aerial telegraphy," indeed ! No other possible way exists for notifying a crowd of the results of any speed or other contest so directly.—*Utica Observer.*

VELOCITY OF AIR CURRENTS.

To the Editor of American Engineer :

Since the velocity of air currents which are to be encountered at different altitudes must be a subject of interest and importance to all who may attempt aerial flight, a summary of the measurements made at the Blue Hill Meteorological Observatory, near Boston, during 1890 and 1891 will perhaps prove useful to your readers. Measurements of the velocities of clouds at all altitudes were made with specially constructed theodolites at the ends of a 1,178 metre base-line and the results calculated with great care. The following table shows the mean cloud velocities in metres per second found between each successive difference in elevation of 2,000 metres :

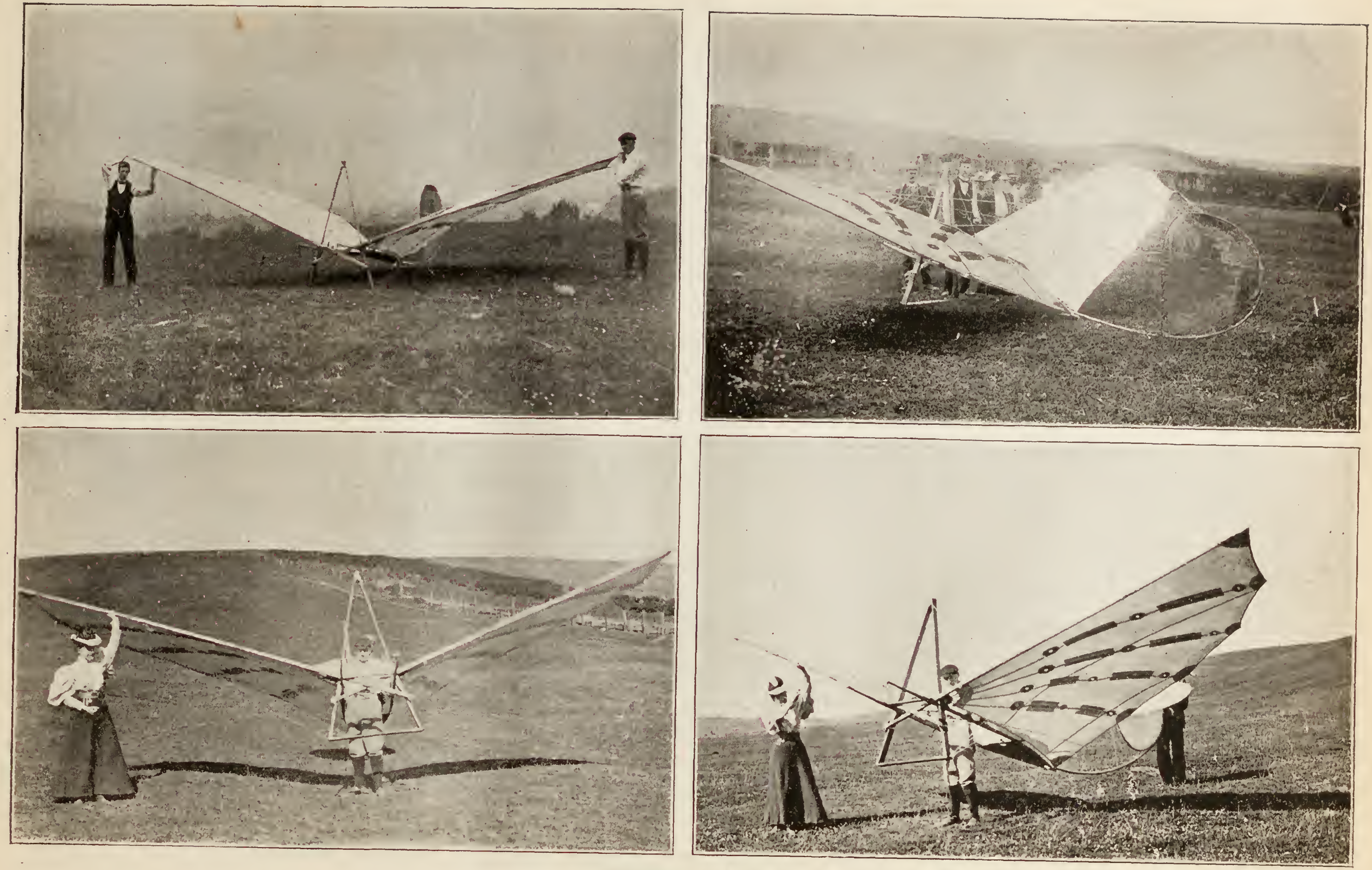
Mean Cloud Velocities in Metres per Second at Intervals of 2,000 Metres Elevation.

Height in metres.	200 to 1,000	1,000 to 3,000	3,000 to 5,000	5,000 to 7,000	7 000 to 9,000	9,000 to 11,000	11,000 to 13,000
Summer	7.5	8.2	10.6	19.1	23.5	31.1	35.2
Winter	8.8	14.7	21.6	49.3	54 0		
Mean	8.1	11.4	16.1	34.2	38.8		

If these results are plotted it is seen that the velocity increases with altitude, both summer and winter, almost along a straight line—in other words, the increase of velocity with altitude is regular and uniform above 200 metres. If difference in altitude be represented by dh and difference in velocity by dv, then in summer $dv = dh \times 0.0027$, and in winter $dv = dh \times 0.0065$.

But since experiments in aerial navigation are at present confined to the vicinity of the earth's surface, the following table giving the increase of wind velocity per 100 metres found for mean differences of elevation of 200 metres during the summer will perhaps prove of greater interest :

Height in metres..	400 to 600	600 to 800	800 to 1,000	1,000 to 1,200	1,200 to 1,400	1,400 to 1,600	1,600 to 1,800	1,800 to 2,000	2,000 to 2,200	2,200 to 2,500	2,500 to 2,850	2,850 to 3,300
Increase in Veloc. per 100 metres.	+1.0	+0.7	+0.9	−0.7	−0.1	−0.1	+.05	+0.3	+0.1	+.05	+0.1	+0.4



PILCHER'S SOARING MACHINE.

The increase of velocity here given is the increase in metres per second between each successive 200 metres, and is found by comparison of cloud and wind velocities. The slight decrease in velocity found between 1,000 and 1,400 metres is probably caused by the ascending slower moving currents from a lower level by which the cumulus clouds at that level are formed. The mean of the first six of the numbers in this table give a mean rate of increase of 0.28 metres per second per 100 metres, as does also the mean of the second six and the mean of all. This would make the formula for the rate of increase in summer $dv = dh \times 0.0028$, which agrees very closely with that previously given for summer.

The extreme velocities which are likely to be encountered at each altitude are indicated by the following mean and maximum velocities of cloud forms which float at different altitudes :

Mean height in metres...........	8,884	6,633	3,856	1,614	508
Mean velocity in metres per second........	38.5	32.5	15.7	11.3	8.7
Maximum velocity in metres per second...	102.6	66.9	33.0	30.8	18.0

The maximum wind velocity for five minutes found in ten years' continuous record on top of Blue Hill, which is 202 metres above sea-level, and about 6 miles from the sea-coast, is 39.4 metres per second ; but this is probably at least 20 per cent. too high, since it is well known that the anemometers now in use in the United States and elsewhere record velocities considerably too high when the wind is above 10 miles an hour.

H. H. CLAYTON.

PILCHER'S SOARING MACHINE.

THE engravings which we give herewith illustrate a soaring machine made by Percy I. Pilcher, Esq., Assistant Lecturer to the Naval Architecture and Marine Engineering Class at the Glasgow University, and Draftsman in the shipbuilding firm of Messrs. J. & G. Thomson, Clydebank. The machine was made to try to repeat the very successful experiments made by Herr Lilienthal, of Berlin. It consists of five parts—*i.e.*, a body piece, a triangle, wings, and a rudder.

The body piece forms the centre of the machine ; on it the experimenter rests ; the back half of this is canvased in, while at the front the spars project like two bowsprits.

The triangle is fixed on to the body piece at the front of the machine, and each side of it passes through a quadrant-shaped steel plate, which is screwed to the body piece and also to the front spars of each wing.

The wings are made of nainsook, the most suitable material to be had at a moderate price. Their shape can be clearly seen in the pictures ; their area is 150 sq. ft. The extreme point of each sail is elevated 4 ft. above the body piece, to the spars of which their inner edges are laced. The sails are kept quite rigid by piano-wire bracings, which come from the apex of the triangle to three points on the upper side of each rib, while the same number of wires are drawn from the under side of each rib to each side of the base of the triangle.

The front spars of the sails cross each other in front of the triangle, and their extremities are lashed to the opposite sides of the triangle, while the inner end of each of the ribs, which are much lighter than the front spars, is finished with a small steel plate, which is fastened by means of a bolt to the quadrant-shaped steel plate on the triangle. The machine is made entirely of white pine, and its total weight, including sails and rudder, is 44 lbs. Mr. Pilcher has permission to practise on a hill at Wallaceton Farm, Cardross. This hill has a fairly steep slope toward the prevailing wind.

The first two days of practice there was an absolute calm, when he simply ran down the hill with the machine, the air taking the entire weight off his feet—*i.e.*, his own weight and that of the machine. He found it necessary to make some slight alterations in the balance of the machine, and also to substitute a vertical and horizontal rudder, as shown in the last two pictures, for the original one, which was vertical only and much smaller.

On the third day's trial there was a wind of 15 miles an hour, unfortunately rather puffy, blowing up the hill from which Mr. Pilcher experiments.

Having rigged at the foot of the hill, he cautiously and with some difficulty proceeded up the hill backward, the wind taking all the weight of the machine ; then, slightly elevating the front edge of his wings, he was taken up 4 ft. into the air, and remained there poised for ten seconds, when, throwing his weight slightly forward, he came down on exactly the same spot as he went up from.

Afterward he ran down the hill several times, taking, without any effort, leaps of up to 60 ft. in length at about 2 to 3 ft. from the ground. Being caught by a side puff, the machine was blown over, and the front starboard spar was too much broken to mend on the field. The following week Mr. Pilcher repeated these experiments with much the same success, but again broke one of the spars. He attributes these accidents to the fact of his wings being so much elevated at the points that a puff of wind from the side can get under one wing and raise it while the other is sheltered. Therefore, before mending the machine described above, he has determined to build another on the same principles, but of entirely different structure, and with the wings very much less elevated. With this machine he hopes to obtain better results. The machine weighs slightly more, but has a correspondingly larger sail area. This machine Mr. Pilcher hopes will be ready for trial in a few weeks.

PILCHER'S SOARING MACHINE FOLDED FOR TRANSPORTATION.

AERONAUTICAL NOTES.

Observatory Balloons.—At the recent races between the sloop yachts *Vigilant* and *Defender*, Professor Carl Myers managed a captive balloon for the New York *Evening World*, in the car of which a reporter was stationed to telegraph the positions and manœuvres of the boats to the office of the paper. With the exception of a trifling difficulty on the part of the reporter in properly focusing his glasses, the scheme was eminently successful, and will probably be repeated at the races of the present month.

A WRITER in the *Deutsche Bauzeitung* has some ideas in regard to the method of propelling the air-ships of the future, which have a certain interest, although they are not altogether new. Regarding as necessary conditions of flight through the air the employment of sustaining planes, and of some propelling force, he says that, instead of the revolving helix commonly used, it would be, in many respects, advantageous to employ a simple jet of air to produce the reaction necessary for driving the craft in any desired direction. The water-jet has already been applied to the propulsion of steamers, with

rather indifferent success ; but he points out that, for sailing through the air, a jet which could be directed to any quarter, at pleasure, by simply turning a valve, would have great advantages, as no other steering mechanism would be required ; and the rotary fan for producing the blast would be a very compact affair in comparison with the helical propellers used, for example, in the Maxim flying machine.

New Flying Machine.—A son of Major Pope, an army surgeon in California, has been constructing a flying machine which he proposes to try on Angel Island—a very appropriate place to try such a machine. A California paper reports that "the young inventor recently took his machine to the heights on the south side of the island in order to have plenty of room and a fresh breeze.

"He felt sure that he was on the right track of success, so far as the principle and the scientific basis were concerned, but he was a little in doubt about his handiwork and mechanical skill. Perhaps the canvas and bamboo rods and cords would stand the strain of his 130 lbs. against a strong breeze ; perhaps not.

"After taking his position within the framework, he turned his face and the front of the machine toward the west. Gently he tipped the wings so as to catch the wind, as does the kite. Then he took a few steps forward and—left the earth.

"Slowly he arose, like a seagull from the crest of a wave. But before he had soared more than 3 ft. from the ground there came a sudden collapse. An important brace in the light frame gave way under the strain, and one of the guide-cords snapped in twain.

"Down came the machine and the inventor ; but his hopes still soared aloft. If he could not fly higher or farther just then, he had flown enough to convince himself and his friends that his work had not been in vain."

Mr. Pope, it is said, is only nineteen years old, and has built his machine in leisure moments, and it has many defects. He proposed to repair the damage, make it stronger, and he says he will fly. Success to him.

French Pigeon Flying.—The European edition of the New York *Herald* recently gave an account of the flying of very large numbers of pigeons in France. "The course," that paper says, was organized by the *Petit Journal*, and was intended to show the vitality of the pigeon breeding industry in that country. No less than 60,000 of pigeons, it is said, were let loose on the open ground between the Pont d'Iena and the Moulineaux Railway. The first start took place about four o'clock in the morning. The President of the Republic was present, and congratulated the pigeon breeders in France on the success of their efforts, which were of such importance to the defence of the country.

At the conclusion of the President's speech 5,000 pigeons, belonging to the Northwest, the West, and the Central regions, were released. The *coup d'œil* was extremely picturesque, the thousands of birds whirling round for some minutes in wide circles before streaming off in long columns toward their destinations.

Seventeen departures took place, the last being at half-past ten.

Explosive Aerial Navigation.—Dr. Edwin Pynchon, of Chicago, proposes to use high explosives as the motive power for aeroplane flying machines. The aerial machine is to be pushed forward by successive explosions of small quantities of dynamite. For work of this kind it is said it becomes simply a matter of "dosage," and after the exact power required is ascertained, it can be secured readily by regulating the quantity or charge of the agent employed on any given occasion. When exploded from the rear of a moving body, the shock of any given charge must be modified in ratio to the speed with which the body is moving, and further care be regulated by the size of the charge used. He thinks that with a ship about double the size of that now being constructed by Maxim, after a full speed of 200 miles per hour has been attained, it can be kept up by the explosion every five seconds of a pair of 60 per cent. nitro-gelatine cartridges, each weighing two ounces ! No, thank you, doctor, we don't want to go on your first trip, while you are diagnosing the "dosage" of dynamite and nitro-gelatin "up in a flying machine."—Editor Aeronautics.

To the North Pole by Balloon.—The daily papers have recently had numerous accounts of Mr. Andree's project for reaching the North Pole by means of a balloon. The following letter from a correspondent in Sweden gives some definite information with reference to the actual progress which the scheme has made :

To the Editor of The American Engineer :

All the money—130,000 kroners—needed by Mr. Andree for his proposed North Pole expedition has been subscribed, and he is now busy making ready to carry out his great scheme.

The subscriptions were as follows :

Mr. Nobel (the great oil magnate)...............	65,000 kr.
King Oscar	30.000 "
Mr. Oscar Dickson, Gothenburg.....................	30,000 "
A gentleman who wishes to be unknown..................	5.000 "
Sum total....................................	130,000 kr.

A later number of the French paper, *L'Illustration*, gives the likeness of Andree and three pictures of his proposed balloon, with draw-lines and sail. With the illustrations is a text particularly remarkable, as it was written by the celebrated aeronaut, who is now over seventy years old, M. de Fonvielle, who has for many years been recognized among men of science, and who, together with the well-known Gaston Tissandier, undertook a number of balloon voyages. It will also be remembered how he, during the late Franco-German War, while Paris was all surrounded by the enemy, ascended in his balloon from the city, and successfully got around the whole German army.

M. de Fonvielle expresses himself in the most sympathetic manner with regard to the Andree North Pole expedition, of which he also gives a detailed description. He thereafter contradicts the opinion expressed by M. Faye in the French Academy of Science—the latter meaning that it would be almost impossible for the expedition, if it once reaches the North Pole, to get away from there. M. de Fonvielle replies that every expedition toward the Pole is, of course, combined with great risk ; but if the members of the expedition will not make the stay at the Pole too long, they will be sure to have a safe return. M. de Fonvielle finally makes a comparison between the Andrie prospect and the late Nansen expedition, and says that if Nansen had offered him a place on his *France*, he would have declined the offer without hesitation ; whereas his answer would be somewhat different were Andrie to give him a chance in his balloon.

Carl G. Lidbeck.

TRANSIT IN AIR.

To the Editor of The American Engineer :

On page 291 of the June number of The American Engineer, under the title "Transit in Air," the writer assumes a "prevalent misunderstanding" in regard to the action or effect of inertia and momentum. He seems to ignore the principal factors in the whole case, and when he asserts that a flying machine, launched from a balloon above the clouds, might go off in any direction under precisely equal conditions without regard to wind and earth, he evidently forgets that there is such a force as gravity. If gravity could be eliminated from actual life as easily as it seems to have been from this writer's mind, successful flying machines would be quite common.

J. P. H.

AERONAUTICAL BOOKS.

Progress in Flying Machines. By O. Chanute. 100 illustrations ; 308 pp., 5¾ x 8½ in.; price, $2.50.

Proceedings of the Conference on Aerial Navigation, held in Chicago, August 1, 2, 3 and 4, 1893. 429 pp., 5¾ x 9 in.; price, $2 50.

Aeronautics. 12 Nos., Oct., '93 to Sept., '94 ; illustrated ; 8 pp., 8½ x 1¾, 10c. each ; $1.00 per set. Bound in cloth, $2.50.

Aeronautics. An abridgement of aeronautical specifications filed at the British Patent Office from A.D. 1815 to A.D. 1891. By Brewer and Alexander. 8½ x 4¼ in., 160 pp. ; illustrated ; price, $2.50.

A Manual for the Practical Use of Aviators and Aeronauts. (German.) Published by W. H. Kühl, Berlin, 1895. 198 pp. Price, $1.00.

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NEW YORK, SEPTEMBER, 1895.

EDITORIAL NOTES.

THE final step has at last been taken, and the *St. Louis* has earned the mail-carrying contract with the United States Government, in accordance with which she was built. The trial in the English Channel last month has placed her in the front rank of ocean liners, and already there are predictions that next year she will prove a record-breaker. The record may be broken, but it will be incidentally to her regular service, and not because the company will abandon its present position of placing safety and comfort in a higher rank than speed. In our news columns we publish a brief account of the trial over the measured course.

ONE of the recent notable events in locomotive practice is the introduction of a locomotive with a single pair of driving-wheels upon the Bound Brook Line between New York and Philadelphia, for hauling the fast express trains. The train running west, to which this engine is assigned, has a schedule time of two hours from New York to the Reading Terminal, including the ferriage and three stops. The train is composed of six cars. The starting is done with as much apparent ease as with the ordinary eight-wheeled engine, and the maintained speed is in several places from 47 to 49 seconds to the mile.

DEAD WEIGHT.

THE improvements in the manufacture of steel which were made thirty or forty years ago, and the general introduction of rails and locomotive tires made of that material, while adding very much to the resources of railroad engineering, seem to have been productive of more or less recklessness among railroad engineers and managers in permitting what probably was a needless increase in the weight of rolling stock. It was found that the improved material would carry much greater loads than iron would without any destructive result, and those who had control of the design and construction of cars and engines seemed to feel that that fact was a license to make them as heavy as they liked, and that no restraint had to be exercised over any addition to the dead weight of such vehicles and machines. Like an imprudent or ignorant person falling heir to a fortune, the need for economy no longer seemed to exist. As a sequence to these improvements in the production of steel, there also came a great increase in wealth and prosperity, and the love of comfort and luxury was correspondingly developed; and—more important still—the capacity to pay for it was acquired by many people who never had it before. Railroad companies and their satellites were not slow to recognize this newly developed taste and capacity; and luxurious cars were soon furnished to supply the demands. With wealth came a love of ostentation and display, and, as a consequence, cars were increased in gorgeousness, and, unfortunately, the heaviness of their decoration and actual weight both increased correspondingly. During this period both freight and passenger cars were steadily increased in weight, the one class from the causes indicated, the other owing to the enormous additions to the volume of traffic, and to the fact that great economies could be realized by increasing freight trainloads, especially when these were hauled long distances. This growth was accompanied by an evolutionary process of the destruction of the weak cars and their parts by those which were strong. When a part broke, the natural and common-sense sequence was to make it stronger, which to the ordinary mechanical mind means to make it heavier. Now such an increase in weight may be essential, and it may not be. Possibly an intelligent investigation might show that strains could be diminished by a different form or forms of construction, or by changing the distribution or quality of the material. Whether expressed or not, the principle was acted upon that if you make anything too strong no one will ever find it out, but if it is too weak the fault will be soon apparent, and so weight was added to one part after another, until now cars and locomotives are veritible engines of destruction to themselves and the track they run on. It is now a process of the survival of the biggest and the heaviest, and, as in nature, that which is weak and defective succumbs.

Perhaps some profitable inferences might be drawn—as the preachers say—"in this connection" by the evolutionary process which has been going on in parallel lines and periods with the increase in dimensions and weight of rolling stock. We refer to the science and art of iron and steel bridge building. Iron bridges began to be generally used about the time that the improvements in steel making, already referred to, were introduced. Now there are two limitations from which a constructor of a bridge cannot escape. These are, first, that if it is not strong enough it will break down; and, second, that if superfluous material is put into it, it will add almost proportionately to its cost. The fall of a bridge is generally attended with a penalty of its own, and as such structures are usually built by contract, the profits of the contractors bear an inverse relation to the cost of the work. There were, therefore, the strongest possible inducements to make bridges strong enough, and next to avoid the use of any superfluous material in their construction. The result has been that the very highest order of engineering science and skill has been called into requisition in designing and building them, and we have the curious anomaly that the static structures on railroads, or those in which dead or useless weight would have no injurious effects—excepting on the first cost and that the extra weight would have to be supported—are made as light as possible, whereas those who are responsible for it seem to be indifferent about the weight of the machines which have motivity, and

which are constantly exerting a destructive action on themselves and their bases of support. It must be admitted that it is impossible to apply exact scientific methods to the design of the parts of a freight car, for example, or to determine their proportions by mathematical calculations to anything like the extent that these are employed in bridge engineering. Of course it is true that, to a very great extent, the design and construction of cars and locomotives is and must be based on empiricism to a much greater extent than the planning and building of bridges is. A bridge must be made to carry definite and generally known loads, and bear strains which are calculable, excepting, perhaps, those which are imposed by master mechanics by the improper counterbalance of locomotives. Doubtless a designer of a locomotive, if he knows enough, could calculate how much strain a rocking shaft, say, would stand without breaking, but then he don't know how much power or how great a force may be required to move a slide-valve, especially if its surfaces are not properly lubricated. If by observation he finds that shafts of a given diameter do not break, he is apt to conclude that they are of the proper size and weight. In this conclusion he occupies a safe position ; but if he carried his empirical methods a little further, he might find that other smaller rocker shafts have also endured the service in which they have been used, and that the larger ones which failed did so owing to being made of inferior material. There is such a thing as scientific empiricism, and if we take Herbert Spencer's definition that scientific knowledge is only "*definite* knowledge," then as soon as empiricism becomes definite it becomes scientific.

A great difficulty which stands in the way of bringing about any great reform in the weight of rolling-stock is that railroads are and necessarily must and should be conducted as business enterprises. It, of course, would be very erroneous to undervalue the kind of ability which is required to make such enterprises succeed, and it is very difficult to define or to apprehend just exactly what the peculiar faculties are which enable men to conduct such schemes successfully, nor will it be attempted here ; but attention will be called to the common deficiency among men of that kind of not being able to comprehend the value of mechanical skill, especially skill in designing machinery. Reference is not made here to inventive ability, although somewhat of that capacity always goes with skill in designing machinery when it is of a high order. What is meant is merely the capacity for shaping and adapting and proportioning the various component parts of machinery to the purposes for which they are intended. The differences in the character and quality and value of this kind of ability is comparable to that which differentiates the colored man who handles a whitewash brush from the tradesman who does kalsomining, and he in turn from the sign and decorative painter, and they again from artists of low degree ; and going still farther, the quality and value of their work is differentiated from that of the great men in the profession. This difference may be and often is expressed in dollars and cents in the price of pictures. At the one extreme, the value of a day's work is represented by a dollar or two ; at the other, by hundreds of dollars. Most railroad presidents and managers can be made to understand the difference in the value of a daub and the work of an artist of talent or genius, but not many of them can be made to apprehend that there is an analogous difference between the designs of a mechanician of first-rate ability and the work of persons of ordinary skill. Most railroad presidents and managers, when they buy pictures for their houses, either want the name of a great artist or the opinion of a competent critic as a guarantee of the quality of the work ; or, if they are building a house or a railroad station, they employ an architect ; but they will entrust the design of rolling stock —especially of cars—to persons of the most ordinary incapacity, apparently without a suspicion that the character of the design will not be better than the ability of the designer. It may be said unhesitatingly that there is and always will be a corresponding difference between the work produced by a botch workman and a master in mechanical design that there is between the pictures of a "duffer" in art and those of great artists.

In the reform of any evil the first step is to ascertain its exact character and extent. To do this the problem of reducing the weight of ordinary box freight cars might be approached by an analytical investigation—that is, the investigator might take the standard cars of each of a half-dozen different railroads, and getting first their correct aggregate weight, could then weigh each part separately and make an accurate drawing of it. These should then be arranged so as to facilitate comparison not only of weight, but of construction. The first thing which would probably appear would be that some one or more of the same parts used on different roads is either lighter or heavier than that used on other roads. In Artemus Ward's significant phraseology, the inquiry would then be in order, "Why is this thus ?" If the Boston & Albany Railroad Company can use a much lighter centre-plate than the Erie Company does (we do not know that they do), why may not the lighter one be substituted for that which is heavier ? The substitution of the one for the other might, and probably would, require the exercise of more or less mechanical skill, or what we prefer to call designing skill, or skill of adaptation, which is a higher order of ability than mere mechanical aptitude.

Having, by such a comparison as has been suggested, ascertained just what and where the differences in weight are, it would then be in order to test the strength of the lighter parts, and see whether it is equal to that of the heavier ones, and adequate to perform the work required of it. A still further inquiry could be made whether, by a different design and distribution of material or the use of a different kind or other method of manufacture, the weight of the part could not be still further reduced. Experience, of course, is the most reliable teacher ; but, as has been remarked, "its lessons often come high." It would seem though, considering how conclusive its tuition is, that we all—but especially railroad companies—should give more heed to it. Daily and hourly it goes on inculcating its lessons on railroads, but those who might profit most by it are often blind and deaf to its instruction. It has often been observed that a scrap heap is a most instructive object of study. It shows what and where, and to some extent how breakage and failure occur ; but in this, as in many other things, hasty inference is apt to mislead. What is needed is systematic records, such as have been kept by some of the heads of the mechanical departments of Western railroads, with drawings showing exactly what and how the parts of cars and locomotives have failed, and the number of failures. Such a record would suggest inquiries into causes, means of prevention, and show what should be avoided or modified. Having collected this information, its use and application, to get the fullest benefit from it, would require a very high order of ability in the adaptation of the design of parts to produce the best results. This latter is perhaps the most important capability which the investigator should have. In his preliminary investigations he should have a mental avidity for new information, which would eagerly accept and follow any clew which would be likely to throw new light on the subject, and also have that judicial turn of mind which would apprehend all the evidence and at the same time hold his judgment in suspense until the testimony was all taken, and then form his judgment of the case on the evidence gathered. The value of this character of mind in relation to other matters is of course recognized, but it seems doubtful whether those who are in supreme control of our railroads realize its value, or even recognize the possibility of

its existence in connection with purely mechanical matters. In fact, the impression is not unusual that a person to be a mechanical genius must be deficient in common sense in some if not most other directions. Invention itself, in its ultimate analysis, is a logical process, and the result of a quick apprehension of mechanical means and resources and more or less acute reasoning thereon. Sometimes the conclusions and inferences come quick as thought, at others they are evolved only after long and laborious investigation and contemplation.

The particular lesson which we want to inculcate here is that in such an investigation as has been outlined, and to effect a reduction in the dead weight of rolling stock, a very similar kind of ability is needed that would be required in any other scientific research, or, in fact, in almost any other enterprise or activity. But in any direction success only comes to those who have mental acuteness, sound judgment, long experience, and familiarity with the relations of the things on which they are engaged, and are capable of making new adaptations and modifications when these are demanded. Such capacity is required of an able lawyer, a successful business man, a great artist, author, or general, and, in fact, of any one who conducts successfully any department of human enterprise. If the services of one or more persons with the requisite mechanical knowledge and experience could be engaged in the task of diminishing the dead weight of cars and other rolling stock on our railroads, it seems certain that much could be accomplished in that direction, and that very large economy would be possible.

That there is great indifference with reference to the weight of cars also appears in various ways. It is doubtful whether one master car builder or railroad manager in fifty could tell or has ever inquired how much the vestibule appliances now so much in vogue on passenger cars weighs. After some considerable experience in the construction of car-seats, we never knew but one railroad man who inquired about their weight, and it is generally very difficult to get accurate or correct information about the total weight of cars. It seems exceedingly probable that such an investigation as has here been outlined might reveal a condition of things the existence of which was not suspected by those who have long been living and working alongside of it.

NEW PUBLICATIONS.

"Engineering News." Our contemporary announces that Mr. William Kent has been appointed a member of the editorial staff of that paper, to take the place, it is presumed, of the late A. W. Wellington. On such occasions it is the duty of the veterans of the press to lift our hands and bestow a patriarchal blessing and invocation for success, which in this instance is a duty which it is also a pleasure to perform.

The Willis Planimetre. By Edward J. Willis, M.E., Richmond, Va. This instrument is illustrated, but very inadequately described in this little pamphlet of eight pages. The engravings originally appeared in the *American Machinist.* On the title-page it is said that it "reads areas in various units; also mean effective pressure and H.P. direct from indicator cards without calculation." The usefulness of this brochure would have been greatly increased if a clear and full description of the instrument and its operation had been given.

Evolution of the Air-Brake. *A Brief but Comprehensive History of the Development of the Modern Railroad Brake, from the Earliest Conception Contained in the Simple Lever up to and Including the most Approved Forms of the Present Day.* By Paul Synnestvedt. New York: *Locomotive Engineering,* 256 Broadway. 112 pp., 5¼ × 7¾ in., $1.00.

This little book is the result of a revision and consolidation of a series of articles which originally appeared in *Railway Engineering and Mechanics.* Its sub-title, however, is misleading; it is not in any sense a "*comprehensive history* of the modern railroad brake." A correct title would be "*Scraps of Information* about the Development of the Modern Railroad Brake." In suggesting this title we do not mean to undervalue "scraps;" all we insist on is that the collection before us is not in any sense a "comprehensive history."

The general scope of the book will be indicated by the titles to the chapters. These are: Introductory; Power Brakes in General; Compressed-Air Brake; Hose Coupling; Air Pump; Governor; Engineers' Valve; Equalizing Discharge Valve; Triple Valve; Quick-Action Brakes; Wenger Brake; Quick-Action Brakes (Continued).

With such a field before him, the author had an excellent chance of making an admirable book by giving a lucid description of the way in which modern railroad brakes have been developed from their early beginnings. The subject, it must be admitted, is not an easy one to elucidate. Early forms of brakes are now, to a very considerable extent, involved in the obscurity with which time so quickly covers what has become obsolete, and the principles of modern power brakes are very difficult to understand and still more difficult to explain, and their construction is very complicated and also difficult of explanation and comprehension. To make a satisfactory book on such a subject, a very great capacity for clear exposition is needed. By no stretch of charity or good nature could this capacity be claimed for the author of the book before us. His description of steam, buffer, chain, hydraulic, vacuum and air brakes in Chapters 2 and 3 would be simply incomprehensible to even intelligent persons who have no knowledge of their principles or construction. The descriptions are inadequate and the explanations not understandable excepting to those who are already acquainted with the subjects. Then, too, some of the engravings are very bad. Take those on pages 18 and 19. They are simply execrable, and incapable of being comprehended. Others are nearly as bad, but they improve as the book advances, those in the latter half being tolerably good. The matter, as has been stated, consists of scraps of information taken apparently chiefly from patent specifications and trade catalogues, and giving illustrations of the various devices and organs of brakes which have been used from time to time, but with nothing approaching to a lucid explanation or description of the construction or operation of the parts illustrated. It is true that a miscellaneous lot of material cannot be collected together, even in a heterogeneous form, without having some interest and value, but in the present instance this value cannot be estimated very high.

The Report of the American Railway Master Mechanics' Association. Some sort of recognition is due to the commendable promptness with which the Secretary of this Association has brought out the Annual Report. The precise date of its appearance on the editorial desk we omitted to note, but if our memorate chronology is not at fault, it arrived some time during the month of July. It appears, too, with a somewhat gay and festively designed cover printed in colors, which betokens prosperity. The typography is excellent, although it is to be feared that remote posterity will not be able to make much use of the volume, owing to the quantity of wood in the paper. Our successors may, however, have little interest in locomotives of the kind which are discussed in this report, and in which some of us take so much pride.

The volume has 331 pages, and the Secretary reports a total of 600 members. A year before there were 587, so that there is a healthy growth. He also reports that Mr. George P. Hodgman, one of the Association's scholars, has graduated with honors at the Stevens Institute of Technology, which is a reminder of the fact that some of us are growing old and may soon be superannuated.

American Steam Vessels. By Samuel Ward Stanton. New York: Smith & Stanton. 500 pp., 8 × 11¼ in., $5.00.

The purpose of the author in compiling this volume, he tells us in his preface, "was to bring together in compact form for the first time correct illustrations and descriptions of all of the various types of American steam vessels from the beginning of their successful construction up to the present day." In the accomplishment of this object he has made a series of pen-and-ink drawings. "These," he says, "have been drawn from reliable sources—from early prints, lithographs, drawings and paintings, mostly in the possession of private parties or steamboat companies; and those of later days from photographs, plans, sketches, etc." From such material the author has made a series of pen-and-ink drawings which were exhibited at the World's Columbian Exposition, in Chicago, in 1893. These drawings are of a very sketchy, scratchy character, and their artistic excellence is not of a very high order. In such illustrations this is not a matter of paramount importance; the essential thing is historical accuracy. The statements made by the author in his preface leave the readers in a state of uncertainty with reference to the illustrations—that is, they cannot know how much of them is historical and how much is

the product of the artist author's imagination. If he was aiming to produce an authentic historical book, that purpose would have been accomplished better if he had reproduced the most authentic illustrations obtainable with the greatest fidelity possible; and if he had then given the fullest and most authentic data and information about the different boats and vessels illustrated, his book would have been a very valuable contribution to engineering knowledge. As it is, the book has not a high order of artistic merit, and its historical value is not nearly so great as it might have been made. All that can be said of it is that it is an interesting collection of picturesque illustrations, which give a general idea of the appearance and construction of early and latter steam vessels built in this country, and of the evolution of this branch of engineering The engravings are printed in blue or purple ink—for what object is not apparent. This color also detracts from the seriousness of the publication. Each vessel is represented by a full-page engraving—generally a side view; and on the opposite page the descriptive matter is printed, which has been inscribed with a pen in more or less ornamental characters, with an accompanying vignette representing a different view of the vessel shown by the full-page engraving and surrounded with very picturesque and ornamental borders printed in a different color from the prevailing purple of the engravings. Each one of these descriptions and the surrounding borders are of different design, and the latter are very picturesque and ornamental and represent some nautical object, as a rope, a fish, a wreck, a lighthouse, etc., in infinite variety. Some of the descriptions are, however, very difficult to read. Take as an example that referring to the steamer *City of Cleveland*, opposite page 260; it requires the strongest kind of eyesight to decipher it, and even with a magnifying-glass it is not easy to make it out. Now, the prime purpose of print is to be read, and no amount of decorative effect in lettering compensates for obscurity in letter-press. Most readers, it is thought, will agree in thinking that the most artistic features in the book are the marginal designs, which are, or should be, totally subordinate to its main purpose.

Beginning with Fulton's *Clermont* and ending with the American transatlantic passenger steamship *New York*, in all 249 vessels are illustrated and described. The book, therefore, is the most complete compendium of the history, progress and development of steam navigation in this country in existence. To a very great extent this history is given in the form of object lessons; and any one with the slightest interest in the subject will soon find himself fascinated with the pictures—those on the one page representing the results of prosaic engineering art, which in this somewhat vague historic record assumes an atmosphere of romance, and on the opposite page we enjoy the coruscations of the artist's fancy in the marginal illuminations. The book is well printed and bound, and, notwithstanding the deficiencies, is extremely fascinating and instructive; and there is no source from which an inquirer can obtain so much information about the evolution of steam navigation in this country, and could get it in such an agreeable way, as he can by going over the pages of this book.

BOOKS RECEIVED.

Transactions of the Association of Civil Engineers of Cornell University. Ithaca, N. Y. 128 pp., $6\frac{1}{4} \times 9\frac{1}{4}$ in.

Proceedings of the United States Naval Institute. Vol. XXI, No. 2. Edited by J. H. Glennon, Annapolis, Md. 438 pp., $5\frac{3}{4} \times 9\frac{1}{4}$ in.

Report of the Canal Commission of Philadelphia, as Transmitted to the Select and Common Councils of the City of Philadelphia. 54 pp., $5\frac{3}{4} \times 9$ in. and map.

Report of the Twenty-eighth Annual Convention of the American Railway Master Mechanics' Association. Edited by Angus Sinclair, Secretary. New York. 331 pp., 6×9 in.

Classification of Operating Expenses, as Prescribed by the Interstate Commerce Commission. Revised issue, taking effect July 1, 1894. 28 pp., $5\frac{1}{4} \times 8\frac{1}{2}$ in. Washington: Government Printing Office.

Decisions upon Questions Raised under the Classification of Operating Expenses, as Prescribed by the Interstate Commerce Commission. Bulletin No. 1. 9 pp., $5\frac{1}{4} \times 8\frac{1}{2}$ in. Washington: Government Printing Office.

Report on the Use of Metal Railroad Ties, and on the Preservative Processes and Metal Tie Plates for Wooden Ties. By E. E. Russell Trabman. (Supplementary to Report on the Substitution of Metal for Wood in Railroad Ties, 1890.) Prepared under the direction of B. E. Fernow, Chief of Division of Forestry. 363 pp., $5\frac{3}{4} \times 9$ in. Washington: Government Printing Office.

TRADE CATALOGUES.

In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. The advantages of conforming to these sizes have been recognized, not only by railroad men, but outside of railroad circles, and many engineers make a practice of immediately consigning to the waste-basket all catalogues that do not come within a very narrow margin of these standard sizes. They are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.

STANDARDS.

For postal-card circulars	$3\frac{1}{2}$ in. × $6\frac{1}{4}$ in.
Pamphlets and trade catalogues	$3\frac{1}{2}$ in. × 6 in. 6 in. × 9 in. 9 in. × 12 in.
Specifications and letter-paper	$8\frac{1}{2}$ in. × $10\frac{3}{4}$ in.

Catalogue of Springs for Street Railways. Charles Scott Spring Company, Philadelphia. 13 pp., 6×9 in. [Standard size.]

We have here illustrated with excellent wood engravings various kinds of elliptic, helical and spiral springs used under and in connection with the lighter class of cars. The company also makes light extension springs for trolley stands, brush holders, and also car window sash springs, all of which are illustrated in the catalogue before us.

An Ideal Engine Room. Harrisburg Foundry and Machine Works, Harrisburg, Pa. $3\frac{3}{4} \times 6\frac{1}{4}$ in. [Standard size.]

Boston has a new theatre called Keith's, the electric lighting plant for which is supplied with three "Ideal" engines built by the above company, which have $15\frac{1}{2} \times 14$-in. cylinders, are rated at 175 H.P. each, or an aggregate of 525 H.P. The theatre is said to be in every way admirable, including the engine-room, which has recently been described in some of the Boston papers, which say that it is in every way the finest and most complete in the world. According to these authorities, it is finished in marble, frescoes, and is lighted like fairyland. There are dados, stuccos, easy-chairs, etc., and from all this scene blue overalls and "jumpers" have been banished, and the engineers, "handsome of feature and strong of build, flit here and there in the performance of their duties in white duck trousers and cheviot suits." These descriptions the Harrisburg Company have reprinted in a convenient form, and have not forgotten to illustrate the different types of their engines with excellent little half-tone engravings in the back part.

The Sterling Emery Wheel Manufacturing Company, Tiffin, O.

Like everything else, the manufacture of emery wheels in these modern progressive times has been undergoing a process of evolution. The processes and appliances of manufacture have been systematized, and, like the traditional pork butchery in the West, when the pigs are driven in at one end and are "passed" out at the other end in the form of sausages, so at the progressive works named at the head of this article, the crude emery stone is brought in and elevated into bins containing the various grades, from which it is carried through conveyers to the places where it is mixed. It is then moulded into wheels, which must then be carefully dried. They are then turned to the proper size and again dried, after which they are subjected to a baking process which occupies four or five days. They are then trued up and tested by running them at double the speed at which it is intended they shall be used. They then become a commercial article. Corundum wheels, to be run wet or dry, are a specialty of this company, and are now used for a great variety of purposes.

Besides the manufacture of emery wheels, this company also makes the grinding and polishing machinery on which their wheels are used. A variety of machines are now included in their list.

The Use and Care of Band Re-saws. W. B. Mershon & Co., Lumber Manufacturers, Saginaw, Mich. 40 pp., $5\frac{1}{4} \times 7\frac{3}{4}$ in. [Not standard size.]

The publishers of this pamphlet, by way of introduction of themselves, say: "We handle about 40,000,000 ft. of lumber annually. Over 90 per cent. of it is dressed or manufactured in our planing and door and box factories. A great deal has to be re-sawed. After years of experience in using the different standard makes of re saws, both circular, solid, and segment and band, and profiting by the experience thus obtained,

our Mr. E. C. Mershon decided to construct a re-saw which would be free from the imperfections which had come to his notice. To do this, it was necessary to make new designs throughout, and to construct a machine new in every respect from beginning to end."

In the catalogue which this firm has issued this re-saw is illustrated and described. The illustrations are passably good half-tone engravings in which several different views of the machine are shown. This is followed by directions for the care of the machines and their saws, especially the latter. Diagrams and directions are given for hammering, straightening, filing, hanging, and brazing saw blades. These are followed by illustrations and descriptions of a combined band re-saw and rip-saw, of which several views are given. The book, which is well printed and papered, ends with a series of testimonials giving evidence of the merits of these machines.

Boring and Turning Mills. The Bullard Machine Tool Company, Bridgeport, Conn. 32 pp., $6\frac{3}{4} \times 10$ in. [Not standard size.]

This catalogue is an example of Bartlett & Company's excellent work—or perhaps it ought to be called high art. The illustrations consist of half-tone engravings representing outside and inside views of the company's factories at Bridgeport. These are succeeded by views of a 37-in. boring and turning mill with one head, a view of a similar machine with two heads; 51-in., 60-in., and two 62-in. machines with two heads; a 30-in. boring and turning mill with turret head; a 24 in. lathe; a turret machine suitable for studs and bolts from $\frac{1}{4}$ in. to $2\frac{1}{2}$ in., and finally a 32-in. combination turret machine. These illustrations are all half-tone engravings, apparently made from photographs which have been touched up to bring out their obscurities. This has not been done, however, in that offensive way which is characteristic of some work of this kind, and which has the appearance of violent striping of the object touched up; but all that has been done is merely to develop what without such treatment would be obscure. The engravings are printed with a fine black line around the edge, and outside of this is a delicate gray tint about $\frac{1}{2}$ in. wide, which is produced by a separate printing. The effect is admirable, especially as the engravings and text are both printed on heavy coated paper, the typography and the binding all being in excellent taste. The cover is of heavy gray rough paper, the binding being effected by a purple string by which the sheets and cover are held together. Short descriptions of the different machines are printed opposite to each engraving.

Condensing and Non-condensing Engines Applied to Rolling Mills. 13 pp., 6×9 in.

Rules and Tables for the Equalization of Power Developed in the Cylinders of Compound Engines. 8 pp., 6×9 in.

List of Standard Fly Wheels. Philadelphia Engineering Works, Philadelphia. 8 pp., 6×9 in. [Standard size.]

The first one of these papers, as its title indicates, contains a presentation of the arguments for the use of compound locomotives in rolling-mills. It is illustrated first by a perspective view of one of the Philadelphia Works tandem compound engines; second, a series of ideal indicator diagrams showing the action of steam in the cylinders of such an engine; third, an outline engraving representing a side view of a similar engine; and lastly, a half-tone engraving of an engine designed on the proportions recommended by this company.

The character and scope of the second pamphlet is sufficiently explained by its title.

The third one describes the "built" fly-wheels made by this company. In these the rim spokes and hub are made in separated pieces and bolted together in a very ingenious and, it would seem from the illustrations and descriptions, a very secure way. An excellent wood-engraving showing a perspective view of such a wheel is shown in the front page, which is succeeded by descriptions of the merits and methods of manufacturers of these wheels. This is followed by tables giving sizes, weights, capacity, etc., of the different wheels made by the company. The last page has rather a poor half-tone engraving showing a double-built wheel being turned in a lathe. These publications are neatly printed, "papered," and bound, and have a general business-like appearance and character.

Compressed Air and the Clayton Air Compressors. Complete Catalogue No 8. Clayton Air Compressor Works, Havemeyer Building, New York. 86 pp. $8\frac{1}{2} \times 10\frac{3}{4}$ in. [Not standard size.]

The uses of compressed air are extending so rapidly, and it is now applied to so many purposes, that any literature on the subject is welcome. The Clayton Company in the publication before us, have republished an article on the Widening Uses of Compressed Air, which originally appeared in the *Engineering Magazine.* They then describe and illustrate the various kinds of air compressors which they make, and from the illustrations and descriptions which are given it will be seen how this branch of engineering has been developed. A somewhat fuller description of the principles and construction of air compressors would, it is thought, have added to the usefulness of this catalogue, but what there is is good. Various forms of governors are described and illustrated, which are followed by short articles on the Loss of Pressure due to Friction in Transferring Air through Pipes; Capacity Lost by Air Compressors, and Suggestions to Correspondents when Writing for Quotations. A large number of illustrations, which represent duplex and single steam-actuated compressors, with tabular statement of dimensions and capacity of different sizes. Similar illustrations and data are given of duplex and single-belt-driven compressors of various kinds. A great variety of forms and sizes, including vacuum pumps, are described, which are used for various purposes. Following these, directions for erecting and operating the compressors and suggestions for ordering duplicate parts. Various kinds of air receivers, steam boilers, the Monarch rock drill, and steam pumps are also made by this company. The volume ends with several pages of testimonials relating to the merits of the Clayton machinery.

Light Cars, Sheffield Car Company, Three Rivers, Mich. Special Foreign Edition, printed in English, French, German, and Spanish. 40 pp., 6×9 in. [Standard size.]

The Sheffield Company, as most of our readers know, manufacture light cars, or what are generally classed as hand cars. One of the principal types of this class are what are called velocipede cars, which are very fully illustrated by excellent half-tone cuts made from wash drawings. The only fault which we are disposed to find with these illustrations is that the occupants of the cars are not, or at least do not look like, working men. Their appearance indicates that they are dressed for some social "function" and not for doing or supervising track repairs. A word of commendation is due to their barber, as their whiskers and mustachios are all faultless.

It is always safe to assume that in writing on any subject there will always be some readers of what is written who will be absolutely ignorant of the subject of the article. To such it will be said that the velocipede which the Sheffield Company makes has three wheels, two of which run on one rail, tandem fashion, and support the person or persons riding on it. A long arm or lever extends at right angles across the track to the opposite rail and carries a small third wheel, the use of which is simply to steady the vehicle and keep the two carrying wheels in the proper relation to the rails on which they run. The vehicle is propelled by means of a vertical oscillating lever connected by cranks and suitable gearing to the driving-wheels.

The author of this catalogue has evidently made the same assumption which we have, and has assumed that his foreign readers are ignorant of the uses to which these cars are put in this country. He has, therefore, written an excellent introductory article describing exactly how repairs are made on American lines, and the rolling stock which they are provided with, and the uses that are made of it.

Succeeding the illustrations of the velocipede cars, some rather peculiar illustrations are given of section hand cars. These have four wheels, and are propelled by horizontal oscillating levers and gearing. The levers are worked somewhat as a pump handle is. The cars were apparently painted a light color, and are taken with a dark background. They therefore have a sort of weird or ghostly appearance which is not altogether pleasing.

An excellent wood-engraving of a push car, stand pipe, and car wheels are also given, with descriptions of each. The light all-steel wheels which this company make have some peculiarities, but would take too much space to describe. A rather sensational picture of a tunnel car and an excellent view of their works completes the volume, which is in every way commendable.

TRIALS OF OIL ENGINES.

Two trials of oil engines have been made in Europe that are of considerable interest in that they have a direct bearing upon the substitution of that type of motor for the steam engine in agricultural work. One was made in Berlin by the German Agricultural Society, and the other at Meaux, France, by the Agricultural Society of that place. The full report of the former, of which we publish an abstract, appeared in the

Arbeiten der Deutschen Landwirthschafts Gesellschaft, and of the latter in the *Bulletin du Syndicat Agricole de Meaux*:

At the German trial only engines working with an inflammable mixture of petroleum gas and air were admitted to the competition. Each engine was tested as follows:

1. With a brake (*a*) at full power for one hour; (*b*) at half power for one hour; (*c*) running empty for half an hour, and about five minutes at the maximum possible power. Indicator diagrams were taken at the same time. During these trials the consumption of petroleum, of lubricating oil, and of cooling water: temperature of the water in and out; efficiency; steadiness in running; variations of speed; and maximum power developed were determined.

2. While driving one or more agricultural machines with rope transmission, when the following points were studied: Simplicity; time required to start; automatic regulation of the speed; accumulation of dirt after running for 60 hours; smoothness in working; time and labor required to clean the engine; noise, smell, inconvenience from the exhaust; and weight of the portable engines with special reference to the cooling water used.

In awarding the prizes, the economy of the engine was calculated as regards consumption of petroleum, of lubricating oil and water; also interest upon capital and cost of repairs; the motor being supposed to run 1,000 hours in the year.

The oil was supplied by the society. American petroleum of 0.80 and Russian petroleum of 0.82 density were used indiscriminately for all the engines.

Since gas motors are out of the question in the country, the development of portable oil engines is a subject of much importance for agricultural proprietors. They obviate many of the difficulties connected with steam engines and boilers, such as weight, transport, inconvenience of carrying water and combustible, danger of fire and constant supervision. These competitive trials were specially designed to test the deficiencies of this class of engine; and it was hoped that a thoroughly serviceable and efficient agricultural oil motor might be the result. Unfortunately many makers who had hitherto given little attention to the subject were induced, in order to take part in the competition, to construct engines too hastily. Badly designed motors were the natural result; and the same may, in the author's opinion, be said of the English engines tested at Cambridge in 1894. In the course of the next few years these difficulties will certainly be overcome. The trials at Berlin showed, not the perfections of portable oil motors, but the defects to be remedied.

Twenty-seven engines were exhibited—viz., six portable and five stationary engines from 8 H.P. to 12 H.P.; six portable and 10 stationary engines from 2 H.P. to 4 H.P.; some were afterward withdrawn. No maker was allowed to have more than two engines tested. Fifteen firms competed—all German except that of Robey. Drawings with detailed description of all the motors are given in the original paper. The author emphasizes the fact that the engines, both portable and stationary, were tested solely for their suitability for agricultural purposes.

All were four-cycle engines; they varied chiefly in their method of vaporizing the oil, valve gear, ignition and regulation of the speed. The vaporization or gasification of the petroleum may take place in different ways. Sometimes it is sprayed into a red hot space, called the vaporizer, and converted into vapor by the heat, the piston then drawing it into the cylinder, together with a proper quantity of air. Sometimes the petroleum is broken up by a blast of air, and injected into a hot chamber, a certain amount of heat being necessary to prevent the recondensation of the oil vapor. Some makers use all or part of the gases of combustion to heat the vaporizer. The oil is sometimes vaporized in a separate space, sometimes an air chamber is used. Although the vaporizer must always be heated, it need not be kept red hot unless it also serves to ignite the charge. If the heat is not supplied by the gases of combustion, a lamp is used; or, the vaporizer being open to the cylinder, the heat of the explosions is sufficient to maintain it at a proper temperature. A lamp must always be used at starting. The vaporizer is the most important part of the engine, because if the oil is imperfectly vaporized the consumption is increased, and dirt accumulates in the engine. The sprayer is usually a kind of nozzle with fine holes through which the oil is injected into the stream of air. The valve gear is about the same as in gas engines. Ignition is generally with a hot tube heated by a lamp. There is no timing valve, the tube being open to the cylinder; but the gases do not ignite until the end of the compression stroke. In some engines the vaporizer is kept red hot and ignites the charge. Very little air must in this case be used to spray the oil, for if the mixture in the vaporizer were inflammable premature ignition would take place. Until the moment of ignition, therefore, the charge should contain too little air to burn, and air for combustion must be separately admitted and forced by the compression stroke into the vaporizer. This arrangement, introduced by Grob, is also used in the Daimler.

In reviewing the portable engines the author remarks that nearly all were ordinary stationary motors mounted on wheels, with the addition of a condenser, an oil and sometimes a water-tank. The judges considered that the aim should be to produce motors complete in themselves, with as little vibration as possible. A decided preference was given to those with horizontal cylinders. With vertical cylinders, the parts of the motor vibrate perpendicularly; and in a portable engine this action, especially on bad soil, causes the wheels to sink into the ground. During the trials the Seck 4-H.P. stationary motor consumed 0.96 lb. of petroleum per B.H.P. hour; in the portable engine of the same type the consumption increased to 1.48 lbs. per B.H.P. hour, and the vibrations were very marked. After the engine had been more firmly fixed the consumption fell to 1 lb.

The trials began by an inspection of all the engines at work, that the smell might be noted. They were then started cold, and observations were made of the time required before they were in full working order, the difficulty of starting, and whether a lamp was sufficient to heat them without the addition of a fan. A Prony brake, an indicator, a counter and tachometre were then added. It is of importance to determine the variations in the speed in oil motors, as they are chiefly governed by cutting out ignitions. In most agricultural engines, even at full power, from 10 to 20 per cent. of the ignitions are missed on account of the variable nature of the work. During these trials, therefore, the ignitions per minute were counted. Each maker supplied his own lubricating oil. The consumption of petroleum was carefully noted, but it was not always possible to measure the quantity of cylinder cooling water.

The engines were worked at the different powers without stopping to test their smooth and regular running. Note was also taken of their cleanliness. When the oil was not perfectly burned, the result was not only a larger consumption, but need for frequent cleaning. A point of importance was whether this cleaning could be carried out by an ordinary laborer; but with most of the engines this was not the case. The protection of the different lamps from sudden extinction, particularly when burning in the open air, was also observed, and specially the arrangements for cooling the circulating water. This water on leaving the cylinder jacket is usually cooled by a current of air from a fan, and it is essential that the fan be driven with regularity, and the pulley and strap not allowed to get wet. In many of the motors it was found impossible to work continuously because the fan strap slipped or came off, and the water was insufficiently cooled. Other difficulties in this respect were also experienced.

After the brake trials, the engines, both stationary and portable, were tested while driving threshing machines; in this work some of them broke down. The best were then selected for a final trial of 60 consecutive hours. These were the Deutz, Hille, Schwartzkopff, Seck, Dürkopp, Langensiepen and Körting.

This trial was purposely made as arduous, and the power as intermittent, and as much like agricultural work as possible. The working efficiency was tested under varying loads, two different oils (Russian and American), and other conditions subject to change during work in the fields. The engines were watched night and day, and the amount of attention they required was noted. The power developed was used to generate electric light and to drive threshing and sawing machines. Although all the motors ran through this trial, some with difficulty, the judges considered that none were worthy of a first prize. With some, when in full work, the water was not properly cooled, the cylinders became too hot, and a violent shock was produced at each explosion. In others the lamp went out; and with all, especially the portable, much vibration was observed, due principally to insufficient cooling of the circulating water. The stationary engines, being connected to a water main did not vibrate so much. The farmers complained most of the difficulty of varying the power in the portable motors.

After the trial they were cleaned in the presence of the judges. The small Deutz and Körting were found less dirty than the others, and took only from 25 to 40 minutes to clean. The larger engines required from 40 to 70 minutes, and two or three men were usually employed. Most of them were found in very good condition.

As the heat efficiency could not be determined without knowing the heat value of the combustible, two samples, one of American, one of Russian petroleum, were sent to the chemical station to be tested for heating value and chemical composition, with the following results:

American petroleum—constituents C 84.54 per cent.; H 14.08 per cent.; O 1.38 per cent.
Russian petroleum—constituents, C 85.52 per cent.; H 13.98 per cent.; O 0.50 per cent.

American petroleum—heating value per lb., 19,380 T. U.; specific gravity at 15° C., 0.797; flashing-point (Abel), 25° C.
Russian petroleum—heating value per lb., 19,580 T. U.; specific gravity at 15° C., 0.825; flashing-point (Abel), 31.5° C.

The results of the trials at the four powers developed, including time required for heating up, number of ignitions missed, and piston speed, are given in the original paper. The weight, price, and size of each engine are also added.

The consumption of petroleum, as shown in the table, varied greatly, the lowest being in the Altmann, 0.83 lb. per B.H.P. hour; the mean consumption of larger power was about 1 lb. per B.H.P. hour. The number of ignitions missed show how much the power can be increased; in agriculture, where the amount of work varies greatly, this is of special importance. The author also calculates the actual power exerted per unit of piston surface and unit of time—in other words, the absolute, or what he calls the specific efficiency of the engine. Although the judges did not intend to base their awards upon this specific efficiency, it was found that the engines developing the highest absolute power were always the best in other respects.

When they were run at half instead of full power, the consumption of oil and number of explosions missed increased considerably. In agricultural work the mean power should be between these two. For instance, the 88 H.P. Altmann ought normally to develop 6 H.P., and its consumption would then be about 1.1 lb. oil per H.P. hour. As the consumption of petroleum is relatively very high when the engines are running empty, it is not advisable that they should do so for long. On the other hand, starting, especially for larger powers, is often troublesome. The times required for starting, and the cleaning after a short run, are given in the original paper.

The indicator diagram is the best guide for studying the cycle of work in a cylinder, especially if a brake experiment be made at the same time. The soot collecting inside the indicator, especially in oil engines, may, however, affect the friction, or an error arise in counting the number of ignitions missed, when not counted continuously. The author selects one diagram as an example to explain a method adopted by him to calculate the working, with reference to the distribution of heat. It is mentioned in his paper on "A Dynamic Theory of Steam Engines," in the *Zeitschrift des Vereines deutscher Ingenieure* (1892, p. 1). He considers the indicator diagram valuable chiefly to show how work is produced and how expended. In the usual method of calculating it the total indicated work is shown, but no count is taken of the fact that this is only a fraction of the total work produced by the combustion of the petroleum, and converted into pressure on the piston. In studying an oil engine it is important to know what becomes of the work, and therefore the indicator diagram must be divided into parts representing so many fractions of work done. The contents of these areas are calculated by the author in a special way, and he shows the amount of work done during admission, compression, expansion and exhaust, by means of vertical ordinates. Account must always be taken of the pressure of the atmosphere on the outer face of the piston. The actual work done will be the difference between the work of admission, compression, expansion, and exhaust, and that of driving back the air. The latter should be subtracted from the work of expansion to give the true indicated work.

The influence of the compression space is considerable in all four-cycle engines. The author shows the proportion between it and the total cylinder volume in all the motors. Thus in the Deutz the compression was nearly half the total volume. During explosion the pressure rose from 7½ to nearly 20 atmospheres. If there were no compression space, the whole of this rise in pressure would be immediately converted into useful work on the piston; with the present methods of construction the greater part is wasted. This pressure generated in the compression space being, like the other values, translated into work and represented by an ordinate, the author proves that it is equal to about three times as much as the indicated work shown in the diagram. If to it be added the energy of the gases discharged, it will be seen that the work wasted is far greater than the work done. The diagram of this pressure, which is shown as the clearance space at one end of every indicator diagram, ought really to be added to it in estimating the work done by the heat given to an engine.

The author classifies the work as follows:

1. Total work, or that shown in all the diagrams combined.
2. Work of explosion, or difference between the absolute and compression work.
3. Work of expansion.
4. Work lost in compression space.
5. Indicated work.
6. Work done on the brake.
7. Work of compression.
8. Work of driving out the air.
9. Work of friction.

All these are represented graphically by curves in the original paper, and the author estimates that only about one quarter of the total work is shown on the brake, the rest being absorbed in friction, compression, and the cycle of work. The mean pressures exerted during these different kinds of work, the friction pressure per unit of piston surface, and the maximum pressure of expansion and compression, are all shown in tables, a study of which reveals how the heat developed has been expended and how much its utilization depends upon the dimensions of the engine, etc. It is not probable, however, that four cycle engines can be greatly improved in this respect, because a compression space is indispensable.

Another table gives the proportions in which, in the different engines, the nine kinds of work were distributed. Thus in the Altmann the total work was 70 per cent. of the total heat given. The heat utilization in this motor was therefore good, but unfortunately there was much vibration.

The author concludes with a comparison of steam, petroleum, and other heat agents. He is of opinion that a field is open for oil motors, which are the most convenient for agricultural purposes, and avoid the difficulties of steam and generator gas engines. They are not, however, so simple, and the motive power, explosive gas, has not the same properties as steam; they need frequent cleaning and much care and attention, but they utilize the heat developed extremely well. In most of the engines there were parts too delicate to be handled by common laborers, although portable motors ought to be made to bear rough treatment, shaking and jolting over bad roads. Although the engines were in some respects defective, many with slight modifications would be suitable for field work. Time, patience, and attention to detail are needed to attain perfection, and few things can contribute more to this desirable result than careful and accurate tests.

At Meaux, eight engines were tested: two English (Hornsby-Akroyd and Griffin), both stationary; three French (a Merlin portable engine and two Niel, one stationary and one portable); two German Grob motors, one stationary, one portable; and one Swiss stationary, by the Société Suisse de Winterthur. The following table gives the principal dimensions and results:

CONDENSED TABLE OF OIL-ENGINE TRIALS.

Name of Engine.	Diameter of Cylinder.	Stroke.	Revolutions per Minute.	Consumption of Russian Oil per B.H.P. Hour.	Brake H.P. Maximum.	Thermal Efficiency.	Cylinder Cooling Water per Hour.
	In.	In.		Lbs.		Per Cent.	Lbs.
Grob (stationary).........	7⅖	7⅖	311	0.59	7.3	21.2 max.	483
Niel "	7⅙	14⅙	183	0.67	6.2	18.7	341
Merlin (portable)..........	6 7/10	6 7/10	283	0.76	4.8	16.6	145
Winterthur (stationary) ...	6 3/10	9⅖	226	0.84	5.2	14.9	133
Groh (portable).	7⅖	7⅖	263	0.92	6.2	13.7	2,557
Griffin (stationary)... ...	6	12	218	0.93	7.4	13.6	330
Hornsby-Akroyd (stationary)...............	8	14 1/10	205	1.0	5.7	10.4	649
Niel (portable)	7⅙	14⅙	177	1.54	6.4	8.2 min.	4,752

The author first draws attention to the fact that oil engines are much more generally used in Germany and England than in France and America, and very few new types are made in the two latter countries. At the Chicago Exhibition scarcely any American oil motors were shown. In France the heavy duty on petroleum has hitherto prevented its general use. Till 1893 the duty in Paris was equal to the value of the oil, and though it has since been reduced, petroleum is still six times dearer in Paris than in America.

All the engines were tested with the same Russian oil, supplied by the society. Its mean density was 0.823 flashing-point (Abel's test), 84° F.; heating value in a Mahler calorimetre 19,872 T.U. per lb.; chemical composition—C 84 per cent.; H 15 per cent.; O and N (by difference) 1 per cent.

Each engine was tested four times—viz., first running light, then at 2 B.H.P., at 4 B.H.P., and at maximum load. The experiments were in most cases continued for three or four hours, and the engine was run for about an hour before

beginning the trials. Each exhibitor was allowed as much oil as he required, and every precaution was taken to make the trials as complete as possible. The following data were noted: oil or spirit required for ignition and lubrication, consumption of petroleum, barometric pressure, temperature of the air, of the water in and out of the cooling jackets, and of the exhaust gases; quantity of cooling water, number of explosions and of revolutions per minute, and variations in the speed. Indicator diagrams were taken where possible. The B.H.P. was determined by a special automatic brake of thin sheet iron, fully described with drawings in the original paper. All the engines tested were single-cylinder, four-cycle and single-acting.

The petroleum was fed into the cylinders either by gravity from a reservoir above, by an oil pump, or injected with compressed air—a method followed in the Griffin engine, and which certainly contributed to its high thermal efficiency. The engines were started by hand, and all had cooling-water jackets. The cooling of the cylinders should be carefully regulated, for if too much heat is carried off the oil is not properly vaporized; if too little, dissociation and "cracking" may occur, with griping of the piston. The author is of opinion that the quantity of circulating water ought to be regulated by the number of explosions per minute—in other words, by the amount of heat generated in the cylinder. In the Grob and Niel engines the same quantity of water was sent by the pump to the jackets, whatever the power developed. Hence the cylinders in some cases were too much cooled, the loss of heat was great, and the consumption of petroleum excessive, the oil going to heat the cylinder walls instead of being turned into useful work. Thus the water cost too much, not only for the unnecessary work of the pump, but to keep the walls at the required temperature. The best engine in this respect was the portable Merlin, in which the water was sent into the jackets by a pump acting only at each explosion, and checked by the governor whenever the normal speed was exceeded.

Drawings with detailed description and a careful criticism of the engines are given in the original paper. As shown by the table, the consumption of the Niel portable engine was very large—more than double that of the stationary engine by the same maker—and the thermal efficiency proportionally small; this is attributed by the author to the large quantity of water circulating in the jacket. The different engines are then reviewed with reference to their thermal efficiency, quantity of heat carried off by the cooling water, heat balance, air used in each engine for the combustion of 1 lb. oil, variations in the speed, and consumption of petroleum. The results obtained under these heads are tabulated, and most of them are represented graphically.

The calorific value of the petroleum, the consumption per hour, and the work done being known, the thermal efficiency can be calculated. Heat is lost to the walls, to the exhaust, by radiation, absorbed by the lamp and by friction. To determine the thermal efficiency the B.H.P. developed was converted into calories and divided by the heat units in the petroleum, giving the proportion of heat turned into work to the total heat supplied to the engine. The best engine in this respect was the Grob stationary; but according to the author the efficiency of all the oil engines was much higher than in agricultural steam engines of the same power. The thermal efficiency is of great importance, for if it is high the engine, although faulty in other respects, can without difficulty be improved in detail.

To ascertain the air used for combustion it was necessary to know the number of explosions per hour, volume of the piston and consumption of oil, and from these the volume of air per pound of oil burned was calculated. The difference between this actual quantity and the theoretical helped to explain why some engines consumed more oil than others. Either the amount of air admitted was too large, and the charge in consequence not sufficiently inflammable, or the quantity was too small, and incomplete combustion and smoke were the result. The comparison of these figures with the thermal efficiency shows how much air ought in practice to be admitted into an engine-cylinder per pound of oil.

A constant speed is most important, especially in engines intended to drive dynamos. The Griffin and Merlin engines were the best in this respect. The consumption of petroleum per hour increased in all the engines with the power, but not to the same extent; it was much affected by the temperature of the walls and the quantity of air admitted for combustion. The oil required for starting, when running empty, for the lamp, and per day, were also determined. The author tested these 4-H.P. engines during a working day of 10 hours, running one hour empty, two hours at 2 B.H.P., six hours at 4 B.H.P., and one hour at 5 B.H P.

A number of comparative experiments and scientific determinations were also made. Professor Witz has shown that the thermal efficiency increases with the speed of the engine, and that the combustion of explosive mixtures is the more rapid the greater the speed. Dr. Slaby has also demonstrated that the losses of heat to the walls unquestionably diminish with the increased speed. In an experimental engine they fell from 40 per cent. to 33 per cent., when the speed rose from 104 to 107 revolutions per minute. Under this head the author remarks that in engines giving the highest thermal efficiency when running at 4 B.H.P. this efficiency increased with the speed. Thus in the Grob stationary engine the thermal efficiency was 17 per cent. with 312 revolutions; in the Niel it was 15 per cent. with 184 revolutions. He considers that the thermal efficiency rises with the speed of the engine owing to the better utilization of the combustible and the smaller loss of heat to the walls. Hence the speed of a gas or oil engine is of much importance. If a small power single-cylinder oil motor runs, like a steam engine, at 100 to 120 revolutions per minute, it is costly, bulky, and the combustible is imperfectly utilized.

The author proceeds to classify the engines according to their cost of working, excellence of construction and running, and thermal efficiency. The comparative perfection of their construction was determined according to the balance of the different parts, capacity of the engine for running empty or at any power, regularity of speed, ease in starting, and time required to start. These were calculated according to different coefficients, and combined in a table with the thermal efficiency. The Grob stationary engine, although giving the greatest thermal efficiency, was not so good in other respects as the Merlin, and the portable Grob motor was the worst.

The main object of the experiments was to bring these interesting and practical oil motors before the public and make them better known, and the author hopes that the results published will help to advance the cause and improve the construction, their value for agricultural and other purposes being now generally recognized.

ROUNDHOUSE AT READING.

The roundhouses, of which we give the reproduction of a photograph on the opposite page, were built by Mr. Milholland for the Philadelphia & Reading Railroad at Reading, Pa. At the present time the one nearest the observer is used as a paint shop, while the other is still reserved for the purpose for which it was built. The peculiarity that strikes one at first sight is the row of gable ends marking the location of each stall This arrangement is one that possesses some advantages over the usual smooth roof, in that the smoke from the stack is carried out more readily by the natural upward draft that prevails. These houses have been kept in excellent condition, and for all intents and purposes are as good as new. The roof is of slate, and the monitor is carried by phœnix columns. The plates are of cast iron, with sockets for the rafters cast on. The rafters themselves are of wood. The turn-table, which, of course, is in the centre of the building, has a cement floor. Above it and just inside the monitor there is a gangway held by sling stays dropping down from the dome trussing. The attractive feature internally is the light and airy appearance of the whole structure, whose roof seems to float rather than be carried on the slender columns beneath. This lightness is, undoubtedly, partially due to the excellent ventilation above the pits. The structure was completed in 1865.

DEFINITIONS WANTED.

A correspondent writes: "Will you please define in your valuable journal what are to many people, quite justly, I think, the vague terms, 'fire surfaces, heating surfaces, and boiler surfaces?'

"In my opinion the *fire surface* is that portion of a boiler which comes in direct contact with the fire.

"The *heating surface* is that portion of the boiler which is actually against the coal or liquid fuel, while the *boiler surface* seems to me to have the broad meaning of every part of the boiler, whether in the fire or out of it."

It seems doubtful to us whether any of these terms excepting heating surface has any exact meaning assigned to it. Any portion of the internal or external surface of a boiler through which heat is transmitted from the fire to the water is generally regarded as heating surface, although Seaton, in his book on the "Marine Engine," says that, "strictly speaking, all surfaces exposed to heat which are capable of absorbing, and their bodies of transmitting, that heat to the water or steam are heating surfaces; but technically only certain parts are reckoned as *effective* heating surfaces, and the aggregate of

such surfaces is called the *total heating surface.* The surface of the upper half of the furnace, or the part above the level of the fire-bars, that of the combustion chamber above the level of the bridges, and the back plates, including the actnal surface of the back-tube plates, are reckoned as the effective heating surface of furnaces and chambers, and are stated separately, chiefly on account of the metal forming them being three or four times the thickness of the tubes."

Robert Wilson, in his "Treatise on Boilers," says: "In estimating the extent of heating surface it is customary to take the whole area of furnace, combustion chamber, flues, water-tubes, etc., in contact with the heat on one side and the water and steam on the other."

Fire surface, so far as we know, has no exact meaning, although it seems as though it should mean that surface through which heat is transmited directly from the fire to the water, either by contact or radiation.

Boiler surface may mean either the external or internal or any other portion of its surface.

ROUNDHOUSE OF THE PHILADELPHIA & READING RAILROAD AT READING, PA., BUILT IN 1865.

THE JAPANESE NATIONAL INDUSTRIAL EXHIBITION IN KIOTO.

In 1877 it was promulgated by the imperial ordinance of Japan, that in order to encourage the development of agriculture, arts, and commerce, the national exhibitions should be held in different parts of the empire. The present exhibition, which was opened in Kioto on April 1, is the fourth, the other three being held in Tokio in the years 1877, 1881, and 1890. For the present exhibition Tokio and Osaka, which are the two largest cities, were rivals for the site of the fair, but the city of Kioto petitioned that the fourth exhibition should be held on the occasion of the eleven hundredth anniversary of the Emperor Kwammu's founding the city. Accordingly the petition met the approval of the government and a large majority of the members of the Imperial Diet.

Before describing the exhibition, it will be interesting to state briefly about the city of Kioto. Kioto is sometimes called Saikio, which means the western capital, while Kioto means simply a capital or *meaco* (or, more properly, *miyako*), as was printed in old maps. The name of Saikio came into use since the revolution of 1868, when Yedo was changed to Tokio, which signifies the eastern capital. In ancient times Kioto was known as Heianjo, or the "city of peace." The city is situated in latitude 35° 1′ 7″ north and longitude 135° 46′ 7″ east. It is 162 ft. above the sea-level, and is near the centre of the province of Yamashiro. Through the eastern part of the city the river Kamo flows. The river Kamo unites with the river Katsura in the village of Toba, a southern suburb of Kioto. The width of the river Kamo as it traverses the city is 120 yds.; but in common with other Japanese rivers, it has three threads of streams in ordinary seasons. In case of heavy rain the freshets come in. The area of the city is 18 English square miles. As to population, it has varied from time to time, and now it is only a half of what it is supposed to have been in the Middle Ages, when the old capital was flourishing. At present the number of houses is 66,000, and the population is 265,000. Nine broad streets run from east to west, which are called Tchijo, Nijo, Sanjo (First Avenue, Second Avenue, Third Avenue), etc. The broadest of these streets is 170 ft., while others are only half as wide. The city is divided into 1,216 squares, just like checkerboard, each being 400 ft. square. Accordingly, the location of buildings is designated in a very simple manner, like the co-ordinates in analytical geometry. As to bridges, the important ones are those which cross the river Kamo.

The site for the exhibition is in the northeastern part of the city, near the incline of the Lake Biwa Canal, which greatly adds to the beauty and advantage of the site. The exhibition grounds have an area of 1,807,200 sq. ft. (about 42½ acres), on which are erected the following buildings:

Industrial Building	151,200 sq. ft.
Machinery Hall	32,400 " "
Agricultural and Forestry Building	51,840 " "
Marine Products Building	19,440 " "
Aquarium	1,260 " "
Fine Arts Building	14,688 " "
Live Stock Building	21,600 " "
Ceremonial Hall	12,960 " "
Total	305,388 sq. ft.

In addition to these principal buildings, there are attached buildings, such as post and telegraph offices, etc., which occupy an additional area of 70,497 sq. ft. Fig. 1 shows the bird's-eye view of the exhibition ground.

The exhibition was opened April 1. The total number of articles exhibited was 170,184, which was 3,111 more than those in the third national exhibition. (Among the articles exhibited

are embroidered goods, satin, many kinds of crape, fabrics, many kinds of silk, velvet, cotton cloths, cords and plaited goods, porcelain, cloisonné, metal wares, lacquer wares, gold lacquer, gold and silver foil, fans, tea, incense, ivory and wood-carving, sculptures, paintings, photographs, fine art curios, cabinets, machinery, all sorts of manufacturing, mining, agricultural, and marine products, etc.) On July 11 the medals and certificates were distributed to the meritorious exhibitors. The following are the gainers of the gold medal of honor:

Sano Silk Factory of Miyagi-Ken	For silk manufacture.
S. Mitsui	" coal mining in Miike colliery.
I. Furukawa	" copper mining and refining in Ashio copper mines.
K. Date	" agriculture in Hokkaido.
Shidzuoka Society of Tea Manufacturers	" tea making.

the exhibition lasting eighty days, commencing March 10. It was memorable as being the occasion for first giving passports by which foreigners, unconnected with legations, were able to go to the old capital. It was visited in May by the Emperor. The next four years it was held in the Imperial palace. In 1874 medals were for the first time distributed among exhibitors of deserving merits. In 1877 the exhibition was held in the palace of the Empress dowager, and was visited by her and the Emperor. It continued to be held there until 1881, when the new building ever since used was completed. The building is entirely of Japanese style, the whole exhibition ground comprising about 12½ acres. Among the articles exhibited are the specimens of high artistic skill and fine art curios.

The Memorial Buildings for the Celebration of the Eleven Hundredth Anniversary of the Founding of Kioto.—Though

FIG. 1.—BIRD'S-EYE VIEW OF THE JAPANESE NATIONAL EXHIBITION IN KIOTO, FOR THE CELEBRATION OF THE ELEVEN-HUNDREDTH ANNIVERSARY OF THE FOUNDING OF THE CITY.

Besides these gold medals, silver medals of honor were presented to 17 exhibitors, and 5,164 medals of different ranks, and 12,548 certificates were distributed to exhibitors of merit. Thus the gainers of prizes were increased also 1,169, compared with the last exhibition, which is comparatively greater than the increase of the exhibited articles, showing the progress of the agriculture and manufactures during the last five years.

The Kioto Imperial Museum and the Kioto Exhibition.—Until recently the Imperial Museum in Tokio was the only one in the empire. Kioto and Nara were, however, old capitals, and they contain many rare treasures, so that there have now been built in both of those cities museums under imperial protection. Among the objects sought are the development of art industries by collecting model specimens, the preservation of materials for historical investigation, and the maintenance of old temples through admission fees to the museums. The grounds have an area of 25 acres, of which the museum occupies about three-quarters of an acre. It was at first intended to erect a building of two or three stories, but finally one of a single story was chosen, to lessen the dangers of earthquake. The small number of windows also adds to the strength, while the light is received from the roof.

The Kioto Exhibition was in the southeast corner of the Imperial Park, and was under the management of the Kioto Exhibition Association. The first exhibition was held in the east Hongwanji Temple for thirty-three days, commencing with October 10, 1871. The next year three temples were used, the removal of the capital to Kioto occurred in 794, the formal occupation of the palace did not occur until 796. According to the Japanese method of reckoning, the eleven hundredth year since that crisis is 1895. Hence this date has been chosen for the commemoration of the founding of the city. The buildings called Kinenden (or the Memorial Hall) have been erected, and the spirit of the Emperor Kwammu is enshrined under the name of Heian Jingu. The grounds in which they are erected are north of the exhibition grounds, and have an area of 12½ acres. The buildings include a memorial hall, eastern and western corridors, two towers called Soriu-ro and Biakko-ro, and a large gate called Oten-mon. With their red pillars and green tiles they form a conspicuous group—that is, in striking contrast to the plain structures used for the exhibition. These buildings add an elegance to the exhibition, just as the Howodo buildings in the wooded island in Chicago did to the World's Fair.

The Memorial Buildings are separated from the exhibition grounds by a broad road running eastward from the northwestern bridge of the compound. Crossing this road from the exhibition, the first structure which attracts the eyes is the imposing two-storied gate called Oten-mon (see fig. 2). This gate can be seen while looking through the northern archway of the Industrial Building. It faces the south, is 60 ft. long, 24 ft. broad, and 64 ft. high. From both sides extend low castle parapets planted with small pine-trees. Passing through a wide open space the Riubiden (a platform 408 ft. × 150 ft. and raised 2 ft. 5 in. from the surrounding

ground) is reached. It can be ascended by four flights of stone steps, the two middle ones being each 57 ft. 5 in. long, while those at the ends are each 44 ft. 10 in. long. The edge of the platform between the steps is adorned with a red lacquer railing having metal ornaments, similar railings being on the sides of the steps.

The Memorial Hall proper or Daigoku-den is the central building that faces the south. It is 110 ft. long, 40 ft. deep, and 54 ft. high, and stands on a platform 5 ft. high, which is ascended by three flights of stone steps. The roof is supported by four rows of pillars. The front is entirely open, while the other sides are plastered white, with three doors on the north side and one each on the east and west. Through the central door on the north there can be seen the Emperor Kwammu's shrine, which is in the rear. According to the custom of eleven centuries ago, the floor is paved with tiles. The two trees in front of the building and on the Riubi-dan are named, like the corresponding ones before the Shishinden of the Imperial palace, Sakon-no-sakura (cherry-tree on the left) and Ukon-no-tachibana (a tree of orange kind on the right).

There are two corridors attached to the Memorial Hall. The eastern is called Soriu-ro and the western Biakko-ro. Each is 169 ft. long, 13 ft. wide, 20½ ft. high, and stands on a platform 2 ft. high. The twin towers are of peculiar construction, the central tower supporting four minor ones. The height of each central tower is 45 ft. 8 in., and of the minor ones 34 ft. 7 in., while the base is 32 ft. 6 in. square.

These Memorial Buildings were designed by Mr. C. Ito, graduate of the Imperial University, and were built according to the style of the eighth century, so as to reproduce parts of the palace then erected by the Emperor Kwammu. However, the dimensions have been reduced, and only a few original edifices are represented. All woods used in the buildings are *ninoki*. Some of the characteristics of the building are as follows : 1. The style is very simple, without any carvings or pictorial ornamentations. 2. They are comparatively low, and give the impression of stability. 3. The rafters are elliptical instead of being rectangular in other buildings. 4. The peculiar terminals of roof called *shibi* (kite-tails) are used, which are only seen on Imperial palaces. They are said to have been used in China in ancient times. Those on the Daigoku-den are of copper and gilded.

The woodwork of the buildings is painted red with lead oxide, while the tiles on the roof have a green glaze ; so that the group presents a striking and picturesque appearance in contrast with the modern style of buildings erected for the exhibition.

The Lake Biwa-Kioto Canal.—The canal is crossed by several bridges near the exhibition ground. The water power station and the incline along which boats with cargo are being moved up and down on wheeled cradles are as if they are exhibited machinery. The cradle is hauled by a steel rope passing round a drum, which is worked by electricity generated by the water power of the canal. At this incline the canal branches into two. The main canal for navigation descends 118 ft. in 1,815 ft. to the level of the city. The gradient of the canal incline is 1 in 15. Double lines of railways, consisting of flat-bottomed steel rails weighing 75 lbs. per yard on wooden sleepers, are laid. The gauge is 8 ft. 3 in. Two cradles, each with eight wheels, are so arranged that one goes up while another is descending. The width of the boat is 7 ft. and the length 45 ft., the weight of cargo being from 10 to 15 tons. The time of passage of the cradle is about twelve minutes.

The electric generating station is situated at the foot of the incline, near the Buddhist temple Nanzenji. Three iron pipes with a diameter of 36 in. are laid side by side. The total quantity of water to be used in the station is 240 cub. ft. per second, with a fall of 120 ft. When the full power is to be used, twenty 120-H.P. Pelton water-wheels are to be constructed. At present only half of the wheels are being used. The Pelton wheels are belted with Edison, Thomson-Houston, and Brush dynamos, with countershafts between them. Lately three-phase dynamo of Siemens & Halske was also laid. Not only are the cradles moved up and down the canal incline by the electric motor, but the electric power is used for spinning, weaving, in the manufactures of clocks, watches, needles, oil, lemonade, ice, soda-water factories, rolling mills, rice mills, for pumping water used in bath-houses, etc., which are situated within a circle of 2 miles from the power station. Besides these, the station supplies electricity in the daytime to the Kioto Electric Railway Company, and at night to the Kioto Electric Light Company. The cost of the power ranges from $20 to $60 per H.P. per year for daily rates of twelve hours ; for eighteen hours the increase is 30 per cent., and for twenty-four hours it is 50 per cent.

The Lake Biwa is the largest lake in Japan, having an area of 500 square miles, and the canal begins at the southwest extremity of the lake in Otsu, and enters the first tunnel of 8,040 ft. long near the famous temple of Miidera, running along the sides of the hills of Yamashina, and piercing two other tunnels, of which the respective lengths are 411 and 2,802 ft. It is just below this third tunnel that the canal divides into two branches, of which the arrangement of the incline in the main canal has been already described. From the

FIG. 2—OTEN-MON (GATE FOR MEMORIAL BUILDINGS) FOR THE ELEVEN HUNDREDTH ANNIVERSARY OF THE FOUNDING OF KIOTO BY THE EMPEROR KWAMMU.

pool at the foot of the incline the canal continues westward and unites with the Kamo River canal. The canal turns to the east, passing a little south of the Kobe-Tokio Railroad as far as the Inari station, whence it turns toward Fushimi, and finally enters the Uji River. Of the total amount of water—300 cub. ft. per second delivered by the canal—240 cub. ft. goes to the main canal and the remaining 60 cub. ft. goes to the branch canal, which leads northward at the head of the incline through the fourth tunnel; then it crosses the valley of the Imperial tomb by a handsome viaduct of 14 arches; then, after passing two more tunnels, it crosses the Takano and Kamo rivers by siphons and continues to Kogawa. The length of the canal is 27,690 ft. The chief object of this branch canal is the irrigation of rice-fields, though partly it is used for power, while the object of the main canal is to open the navigation and to produce electric power. The length of the main canal is 36,650 ft., and the difference of the level is 140 ft. Of this difference of level, 129 ft. are arranged with a lock and incline, while the remaining 11 ft. by the gradiant, varying from 1 in 2,000 to 1 in 3,000.

The construction of the canal was proposed by Mr. K. Kitagaki, governor of Kioto-fu, in 1881, when the fortunes of the city were at the low ebb. As the city, which for ten centuries had been the capital of the empire, was robbed of much of its former grandeur after the seat of government was removed to Tokio in 1868, it was thought that the new canal would certainly do much to restore its prosperity. In order to attain this aim, Governor Kitagaki took the necessary measures in carrying out the work, Professor S. Tanabe, of the Imperial University, being engineer-in-chief. The work was commenced in August, 1885, and was completed in 1891. The total cost of the work amounted to nearly $1,000,000, which is the property of the city, though having some public debt.

The work of the Lake Biwa Canal, indeed, added a new eleganee to the natural scenery, ancient temples, and artistic skill of the inhabitants of Kioto. In this memorable year for commemoration of the founding of the city, while the national exhibition was being held, it is a remarkable fact that Kioto became a military headquarters of the victorious war with China, when the reigning emperor was in the old palace. There was a great influx of people not only from different parts of the empire, but also from foreign lands, who were attracted thither by the fame known in the Columbian Exposition. It is a noticeable thing that while Japan was gaining brilliant victories in the war with China, she did not neglect to prepare for the industrial exhibition, in which her great progress made in manufactures and arts within the last five years was shown.

STANDARD CARS ON THE SOUTHERN PACIFIC RAILROAD.

What may be called the mechanical situation existing on the lines constituting the Southern Pacific system differs from that on other large railroad systems, in that the jurisdiction of the Superintendents of Motive Power of any one of the properties making up the lines of the system does not extend beyond the rolling stock of his particular line; first, by reason of the great distance between the principal shops on the lines (it taking four days for a letter from Houston to Sacramento); and, secondly, the State of Texas requires that each company chartered in the State shall be operated by its own officers. This has made it somewhat more difficult than ordinarily is the case on other roads to establish and maintain standards in rolling stock, so essential on properties where there is so large and so constant an interchange of cars between the lines of the system. This is particularly true in the State of Texas, where in freight trains of the several lines are frequently hauled cars of all the other lines. An arrangement, however, has recently been perfected by which all the lines concerned co-operate in the establishment and maintenance of common standards, and the following circular is the first step in that direction.

Among the difficulties experienced in this matter (undertaken some three years ago) was the differing opinions of the officers of the mechanical departments of the different lines about details of construction, and the absence of definite information on the service of the details on cars already in use. It frequently occurred that, no sooner had a new lot of cars been built on previously agreed specifications, than the mechanical department of one of the lines would suggest improvement or put in use an improvement on his own line, considering only the apparent benefits of the improvement for his own line, without considering its effect on the other lines or the disadvantages which might result from disturbing existing standards. In some instances the causes for changes made were mainly incidental, and would occur but seldom in the ordinary course of business.

This state of affairs resulted largely from the fact that the officers of the mechanical department of each line were governed only by the experience of their own particular line, and proceeded to make changes without reference to the effect on the properties as a system. As already stated, it required days to hear from the mechanical officers of the other lines, and they had no time to give these matters the consideration to which they were entitled.

In issuing the following circular it was not intended to check improvement which is constantly being made in rolling stock, but to proceed in a systematic manner, making improvements only from as correct information as can be obtained on questions affecting proposed changes in established standards.

The following is the circular referred to:

SOUTHERN PACIFIC COMPANY.

MOTIVE POWER STANDARDS.

New York, May 18, 1895.

By July 1, 1895, there will be in service about 1,300 freight cars built upon common standards, in accordance with the circular letter of the President, of December 7, 1894, providing for the establishment and maintenance of common standards in rolling stock and motive power.

It is now desired to determine by careful observation the merits of the cars built under these standards, and such other rolling stock as may hereafter be built under common standard specifications; and remedy as far as practicable all deficiencies in construction which may manifest themselves in the use of common standard rolling stock, perfecting by these methods the designs for common standards and bringing the equipment up to the highest degree of efficiency. The data, in respect to the service of these cars and other common standard rolling stock, can only be ascertained from the character of the current repairs made. These repairs are distributed over about 8,500 miles of railroad; and some systematic method for the collection of information, regarding the character of the repairs made, will be necessary to make the information available and valuable for the above purposes. It has, therefore, been arranged:

1. All cars or other rolling stock built under common standard specifications will be known by the designation [C. S.] This designation will, on the freight cars herein referred to, be found under the medallion, and to the right of the words "Westinghouse Air Brake;" thus [C. S.]

2. At all shops or junction points of the roads concerned where running repairs are made, a report is desired on a blank furnished for that purpose [Form C. 38], of the general character of repairs, and particularly renewals made on such cars. The information desired in respect to such repairs and renewals is:

(*a*) The particular part repaired or replaced.

(*b*) The location of fracture or breakage, and cause, as far as this can be correctly described.

(*c*) The total number of hours of all men employed in making said particular repair, as nearly as this can be given.

3. The above applies only to repairs incident to current use of the cars, and not to cars wrecked or damaged by derailments and collisions, or causes other than those incident to the general service in train or in yards.

4. These reports should be forwarded from the division or junction shops to the Superintendent of Motive Power and Machinery, at the close of each month, or at such other intervals during the month as the Superintendent of Motive Power and Machinery may direct. As early as practicable thereafter these reports should be forwarded by the Superintendent of Motive Power and Machinery to the Mechanical Engineer, with such recommendations in the matter as will in his judgment be of benefit to the service.

5. The above applies to all cars and other rolling stock of the Southern Pacific Company and affiliated lines, stencilled [C. S.], regardless of the initials thereon of company owning it.

The above arrangements will assist largely in forming a correct conclusion about the wear and service of existing standards, and in what direction and to what extent it is desirable to make improvements in them. If the monthly reports of Superintendents of Motive Power and Machinery are supplemented as occasion arises by their observations in respect to the common standards in use, they will, by these measures of observation, secure in time standards in rolling stock which will increase largely its service to the public and general efficiency, and reduce the cost of its maintenance.

William Mahl,
Second Assistant to President.

NOTES AND NEWS.

Andrew Carnegie has aroused British wrath by saying that it would pay England to burn up her railroad equipment and replace it with American models.

The Siberian Railroad from Lake Baikal to Vladivostock is now completed ; the route runs further south than was originally planned. Of the 6,000 miles between St. Petersburg and Vladivostock, 2,300 are now built and 3,700 remain to be completed.

Fast Torpedo-Boats.—It is reported that the British Admiralty has placed orders with the Messrs. Thompson, shipbuilders, of Glasgow, for the construction of three torpedo destroyers capable of maintaining a rate of speed of 36 land miles per hour. The intention is that these boats shall be the fastest vessels of their kind afloat.

Prizes for Essays on Profit-Sharing.—Two prizes of $5,000 each, for essays on profit-sharing and on trade-unions, open to persons of any nationality, are offered by Comte de Chambrun, the endower of the new Social Museum in Paris. The essays on profit-sharing must be handed in before December 31, 1896 ; those on unions before December 31, 1897, to the Société des Études Sociales in Paris.

Russian Naval Notes.—During the past few months four Russian armored ships have been launched. This has not stopped the activity of Russian State naval departments. The launched ships are now supplied with engines and armament, and on the slips upon which these were built four new ships have been begun. The first-class armored ship *Sisoï the Great* received the boilers and engines made by the Baltic works, and a portion of side armor of the lower citadel, in the summer of 1894. The engines will be tested during the coming summer.

The Armored Cruiser "Dupuy-de-Lome," 6,300 tons, has, after repeated alterations, again failed to answer satisfactorily the demands made on her. She is a long narrow vessel with three screws, and the three sets of engines constantly hamper one another. This vessel was launched in 1890, and is still in the experimental and alteration stage. *The Times* says : "The Americans have had greater success with three screws in the *Minneapolis* and *Columbia* class, but those vessels, in addition to greater lengths, have nearly 7 ft. more beam than the *Dupuy-de-Lôme.*"

Locomotive for the State Railways of Hanover.—We are in receipt of a letter from Mr. August von Borries, stating that the express passenger locomotive, as illustrated by us in our issue for June, was not built by him, as we asserted, and that if it had been, he would have built it as a compound. The design will be so constructed in the future because it now uses a great deal of coal, and is not sufficiently efficient to do the work that it is called upon to perform.

Failure of the "Columbia's" Boilers.—During the speed trial of the cruiser *Columbia* across the Atlantic, Captain Sumner reported : "It was not deemed practicable to make the last 24 hours run under forced draft because of the unreliability of the boilers (we were blowing out tubes at 140 lbs. pressure), the loose state of the engines from the long run, the great fatigue of the crew, and, above all, the impracticability of getting a coal supply to the boilers with sufficient rapidity, as the coal was located at this stage of the run."

Power without Shafting.—An indication of a tendency toward the construction of shops without shafting is given by the erection of a power building in Pittsburgh designed for occupancy by a large number of small manufacturers. No belting, shafting, or pulleys will be used, but a complete system of electric motors will be installed upon each floor. It is also announced that the locomotive works at Düsseldorf, Germany, have been using electric motors for almost a year in the foundry, resulting in a large saving over the former method of using belts.

The Heilman Locomotive.—The French Western Railway Company has made arrangements with the Heilman Company for two electric locomotives of 108 tons 5 cwt. 1.012 qrs., capable of dragging 196 tons 16 cwt. 3.295 qrs. at the speed of 62 miles per hour. *Railway News*, quoting from the *Journal des Transports*, says these locomotives, the power of which will be triple that of the one tested last year on the Nantes Line, are intended for the Paris-Dieppe Line, and the company hopes to be able at the end of next June to make the journey in two hours.

Endurance of Wire Rope.—A rope of Cradock's improved crucible steel, an inch in diameter, after fourteen years' constant use, during which it was never repaired, though it has hauled 1,500,000 tons, has been taken out of a Nottingham colliery ; another steel rope, 3,400 yds. long and 2½ in. in circumference, was used continuously in a Sheffield colliery for eleven years and eight months ; a third rope, 392 yds. long and 5 in. round, was used on the under side of a drum, near Barnsley, for three years and ten months, lifting 735,679 tons of coal in that time.

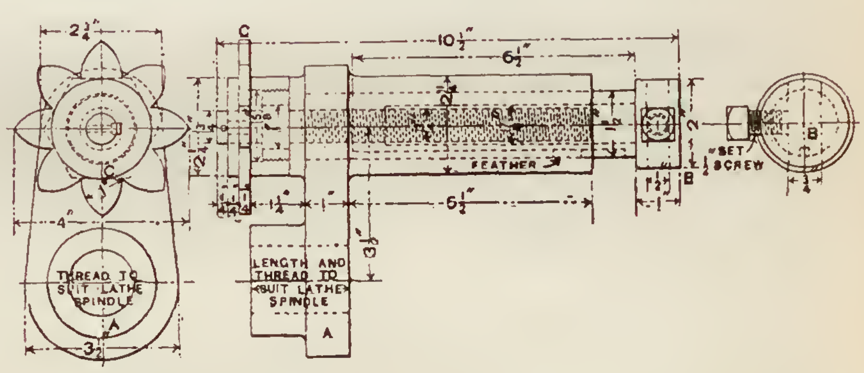
New Russian Imperial Yacht.—This, it is said, will be the largest yacht ever constructed, and was to be launched on the Czar's birthday. It will be of 5,300 tons, while the length is 430 ft. *Pole Star*, the present imperial yacht, is 2,000 tons less, and is only 350 ft. long. The new yacht has engines of 12,000 I.H.P., to give a speed of 20 knots at sea, while the old yacht had engines of only 6,000 I.H.P. The new yacht, too, will have Belleville water-tube boilers. The keel-plate was laid in the summer of last year by the late Czar, and the cost is put at £400,000. She is named *Standard*, and will have a complement of 370 officers and men.

To Prevent Waste of Electricity.—The Baltimore *Sun* says that an inventor in that city has devised an insulated conductor of electricity for railways operated by the underground system. In reference to his invention he says :

"Its object is to prevent the enormous waste of electricity to which all underground railway lines are subject on account of dampness in the conduit and the large amount of iron with which the conductor is surrounded. This is accomplished by partly covering the conductor, which is a bar of steel, with enamel similar to that used on kitchen utensils known as granite ware. The substance is virtually glass, one of the best non-conductors known."

Timber Water Pipe.—Some interesting details are given of the construction of the water-works of Denver, Col., a notable innovation consisting in the laying of 16 miles of 30-in. wooden conduit, also a considerable length of 44-in. pipe. The timber used for this purpose is California redwood, and the 30-in. conduit is adapted to stand under a head of 185 ft. In this work the mains were composed of staves dressed very smooth to cylindrical sides and radial edges, being held to the cylindrical form by mild-steel bands placed at a distance apart, depending upon the head, but never exceeding 17 in. The pores of the wood are filled with the water under pressure, so that it oozes through to a slight extent, thus insuring permanent preservation, and the interior finish is so smooth that the most advantageous conditions of flow are secured.

Device for Turning off Lifting-Shaft Journals.—In the turning off of lifting-shaft journals for locomotives, the size of the work and the size of the lathe upon which the said work is done are usually out of all proportion with each other. To use a lathe large enough to swing the shaft is an awkward way of doing the job, and yet to use a tool of smaller size a special wrinkle of some sort is required. Such a wrinkle is in use in the shops of the Baltimore & Ohio Railroad. Its principle lies in that the cutting tool is fastened to the live spindle of the lathe and the shaft held stationary between the centres. The device is clearly shown in our engraving. The hub *A* is



DEVICE FOR TURNING OFF LIFTING-SHAFT JOURNALS.

screwed upon the spindle, and on the elongation at *B* there is a tool-holder that is moved in and out of the sleeve by the screw feed driven by the star motion at *C*. A centre with a long shank is put in the spindle, coming out far enough to carry the end of the shaft beyond the tool that is held at *B*, when the tool-holder is screwed home. The shaft is placed on the centres, and the tool revolved about it. In this way the job can be done on a lathe of ordinary swing and much smaller than that which would otherwise have to be used.

Deficient Stability of French Ships.—"Many of the French fighting ships have shown deficient stability, and their superstructures and military masts are being rapidly removed. This is being done to the *Magenta* at Toulon, and at Brest the *Hoche* and the *Brennus* will be in dockyard hands for many a day, the after fighting mast in both cases being bodily removed ; and the *Charles Martel*, now building, is to be altered in the

same way from the original design. The cruiser *Friant* has had both masts cut off as low down as the bridge; thus she loses four machine guns previously placed in her fighting tops. As this vessel was altogether overweighted and floated deeper than her design, she is to have four torpedo-tubes and the proportionate torpedoes and all the heavy gear appertaining to them discarded, and the crew is to be lessened. The *Lansquenet* has again broken down on trial.—*The Times.*

Brick-dust Mortar.—The use of brick-dust mortar as a substitute for hydraulic cement, where the latter cannot be obtained, is now recommended (the *Southern Architect* says) on the best engineering authority; experiments made with mixtures of brick dust and quicklime showing that blocks of $\frac{1}{2}$ in. in thickness, after immersion in water for four months, bore without crushing, crumbling, or splitting, a pressure of 1,500 lbs. per square inch. It is considered, too, that the addition of even as small a proportion as one-tenth as much brick dust as sand to ordinary mortars is preventive of the disintegration so often characterizing mortars used in the masonry of public works. The use of brick dust mixed with lime and sand is said to be generally and successfully practised in the Spanish dominions, and is stated to be in all respects superior to the best Rosendale hydraulic cement in the construction of culverts, drains, tanks, or cisterns, and even roofs, whether for setting flat tiles or for making the usual tropical flat roof. The proportions used there in the manufacture are, approximately, one of brick dust, one of lime, and two of sand, mixed together dry and tempered with water in the usual way.

The "Alert" and "Torch," the new sheathed sloops, sister vessels of 960 tons displacement, were successfully floated out of dock at Sheerness Dockyard recently. Built from the designs of Mr. W. H. White, C.B., Director of Naval Construction and Assistant Controller of the Navy, the *Alert* and *Torch*, which represent a new type of sloop, were laid down in No. 2 dock on December 7, 1893. They have been built with steel plating $\frac{1}{2}$ in. thick, which is covered with teak wood sheathing, 3½ in. thick, to a height of 2 ft. above the water-line. The stern and rudder posts are of phosphor bronze, and were cast at Sheerness Dockyard. They have no armored protection, but a steel water-tight deck runs above the boiler and engine-rooms, and also forms a division between the upper and lower coal bunkers. Their principal armament will consist entirely of quick-firing guns, the vessels having been designed to carry six 4-in. guns and four 3-pdr. guns, together with two machine guns. Their engines and boilers, which have been made at Sheerness Dockyard, have been designed to register 1,400 H.P. under forced draft, with a speed of 13.25 knots, and 1,100 H.P. under natural draft, with a speed of 12.25 knots. They will be fitted with three masts and will carry yards on the fore and mainmasts.

The Most Important Recent Improvement in Firearms.—In reply to an inquiry made to General Schofield recently by a reporter of the New York *Sun* as to what he considered the most important improvement in firearms in the seven years he has been at the head of the Board of Ordnance and Fortifications, he promptly said:

"The rifled guns and rifled mortars for batteries are by all odds the most important of recent improvements. The importance of these long-range guns for coast defence cannot be overestimated. The rifled mortar, which, with the aid of position finders, can drop its missiles into a vessel three or four miles out from shore, is the most effective protector of our coasts.

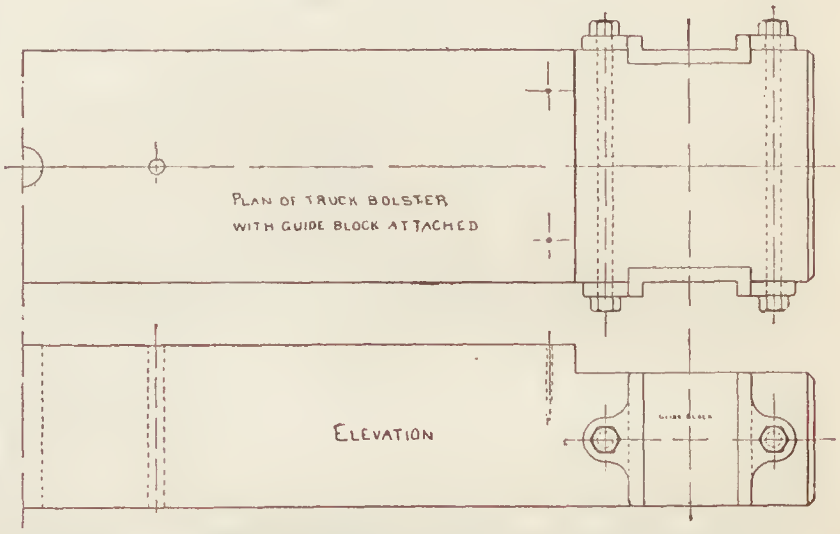
"Some persons might say that the torpedo boats, in the construction of which such a great advance has recently been made, deserve first place in a list of modern improvements. Certainly they form a factor of increasing importance in the problems of war."

A Sea-Monster of the Olden Time.—Is it true that our ram battleships are but old inventions in new forms? It looks like it. Some one has unearthed a curious announcement which appeared in the *Mercurius Politicus* for December 6, 1653—that is, two hundred and forty years ago—to the effect, as stated by the Dundee *Advertiser*, that "the famous monster called a ship, built at Rotterdam by a French engineer, is now launched." In a description of the vessel its capabilities are thus detailed:

"1. To sail by means of certain instruments and wheels (without masts and sails) as swift as the moon, or at least 30 miles every hour. 2. Both ends are made alike, and the ship can be stop'd at pleasure, and turned as easily as a bird can turn. 3. In time of war it can, with one bounce, make a hole under water in the greatest man-of-war as big as a table, and in an hour's time will be able to sink 15 or 16 ships, and in three or four hours will destroy a whole fleet. 4. She will be able to go to the East Indies and back again in eight or nine weeks. 5. She may be used to kill whales in Greenland, so that 100 ships may be laden in fourteen days. 6. She may be used to break down any pier or wooden work with great ease."

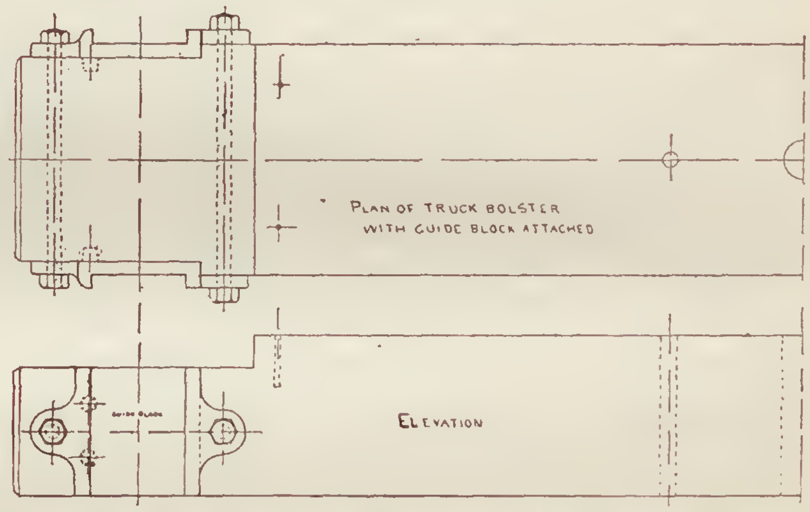
A wonderful "monster" this must have been. What, one is curious to know, was her fate?—*Exchange.*

Bolster Guide Block for Freight-Car Trucks.—The attached sketches show the plan and elevation of a truck bolster used in freight-car trucks with bolster guide-block attached. Sketch No. 1 shows the old style truck bolster and guide-block, in which it can be seen that the bolster is the same width throughout, with simply the two spaces cut out to allow the guide-blocks to fit in and takes two bolts of same length for each end to hold guide-blocks. Sketch No. 2 shows the new style truck bolster and guide-blocks. This bolster, is not the same width throughout, but is cut down on the end equal



No. 1. OLD STYLE TRUCK BOLSTER WITH GUIDE-BLOCK.

to the amount the guide-blocks set in the old style bolster, and the flange on guide-block is changed accordingly, which necessitates the use of a shorter bolt through the end of bolster, but is fully balanced by doing away with the never-ending complaint regarding the split-off ends of truck bolsters, and car inspectors at interchange points refusal to receive such cars without defect cards. When the ends split off of truck bolsters



No. 2. NEW STYLE TRUCK BOLSTER WITH GUIDE-BLOCK.

all that is necessary to apply the new style guide-block is to true up the surface against which guide-block bolts, bore two holes for the steady pins, and by using one short bolt in connection with one long bolt, as shown, the work is accomplished and it makes a very neat appearance.

The Action of Fly-wheels.—An interesting experiment is described by M. V. Bablon, who in the endeavor to secure the more uniform running of a dynamo driven by a gas engine, first proceeded to determine the amplitude of the angular displacement of the fly-wheel relative to the normal position it should occupy if speed were invariable. The fly-wheel was illuminated by means of a Geissler tube, excited by a Ruhmkorff coil, regulated so that its flashes coincided with the frequency of the passage of the fly-wheel arms through a given position. So long as the fly-wheel velocity was constant, the arms were visible at this instantaneous position by the light of the flashes, and the wheel appeared to be stationary; but as the velocity varied and the wheel ran slower, it appeared to have a slow retrograde movement, for the arms did not reach the given position at the moment of flash. Then, a fresh ex-

plosion taking place, the wheel would appear to slowly reverse its movement and overrun the flash point. In fact, the wheel appeared to swing slowly between two extreme positions, and its angular movement was easily measurable, the eye grasping readily the progress of the alternate advances and retrogressions. In light running, with one explosion every four or five cycles, the maximum angular movement was 50°. With load on, and only one explosion missed out of four or five possible, the angularity was 8° for successive explosion cycles, and attained barely 12° after a non-explosive cycle followed by explosion.

Hodgkins Prizes Awarded.—In 1891 Thomas George Hodgkins, of Setauket, N. Y., established a fund which was placed in charge of the Smithsonian Institution at Washington, and, according to the New York *Sun*, specified that the income from a part of this fund was to be devoted to the increase and diffusion of more exact knowledge in regard to the nature and properties of atmospheric air in connection with the welfare of man.

An announcement of the prizes which were offered was made by the Secretary of the Smithsonian Institution on March 31, 1893. The offer of a prize of this value excited general interest throughout the civilized world, and papers were received from nearly all those who were at all interested in this branch of scientific research.

The Committee of Award for these prizes has completed its examination of the 218 papers submitted in competition by contestants from almost every quarter of the globe, and has made the following decisions :

First prize of $10,000 for a treatise embodying some new and important discoveries in regard to the nature or properties of atmospheric air, to Lord Rayleigh, of London, and Professor William Ramsay, of the University College, London, for the discovery of argon, a new element of the atmosphere.

The second prize of $2,000 was not awarded, owing to the failure of any contestant to comply strictly with the terms of the offer.

The third prize, of $1,000, to Dr. Henry de Varigny, of Paris, for the best popular treatise upon atmospheric air, its properties and relationships. Dr. de Varigny's essay is entitled "L'Air et La Vie."

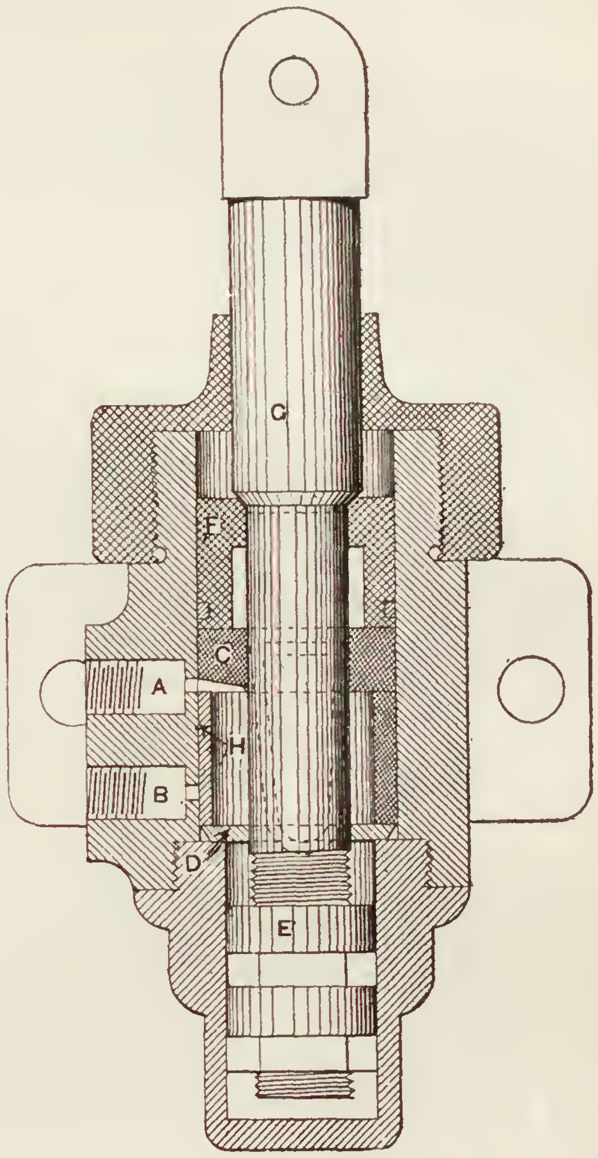
A considerable number of papers submitted in competition received honorable mention, coupled in three instances with a silver medal, and in six with a bronze medal.

A Trial of the British Torpedo-boat Destroyer "Boxer," built and engined by Messrs. J. T. Thorneycroft & Co., was made recently. The vessel proceeded to the trial ground, where six runs on the measured mile were made with the following results :

Time.		Speed.	Revolutions Starboard.	Revolutions Port.
Min.	Sec.			
2	2.6	29.364	425.7	400.3
2	4.4	28.939	420.5	419.6
2	1 4	29.654	415.1	407.7
2	9	27.907	408.3	406.0
1	58.6	30.354	418.3	411.8
2	9.8	27.735	411.4	410.0

The mean speed during three hours' running, as measured by the total number of revolutions made, was 29.17 knots ; the total distance covered in that time being 100.6 statute miles. This speed exceeds that ever obtained on an official trial by more than a knot. The four vessels of the class—namely, the *Daring*, *Decoy*, *Ardent*, and *Boxer*, all built by Messrs. Thorneycroft & Co.—have each beaten the record in turn and are now the four fastest ships in the world.

A Locomotive Bell-Ringer.—The accompanying illustration shows a very simple form of bell-ringer that is in use on some of the Western roads. It may be operated by steam or compressed air, though the latter is to be preferred, in that it requires no special piping for the exhaust and any leakage that may occur does not disfigure the jacketing or the engine. The ringer is placed at the bottom of the bell-bracket in an upright position, just as it appears in the engraving. The steam or air is piped to enter at *A*. When the bell is standing the pressure is exerted upward against the ring *C*, which crowds against the piston *F*, and through the latter upon the stem *G*. The stem *G* is connected to the crank of the bell by a rod, and as long as this crank is in the vertical position it is on the dead centre, and the bell does not ring. By pulling on the bell-cord the crank is swung off from the dead point, and an upward thrust given to it by the steam or air. The piston *F* is thus pushed up to the upper limit of its stroke, and an impulse given to the bell that carries it beyond, causing the stem *G* to rise away from the piston *F*. In doing this the piston *E* is raised until it strikes the ring *D*, which with the shell *H* is lifted until the exhaust-port *B* is uncovered. When gravity overcomes the upward motion of the bell and it swings back the steam or air that has been imprisoned within the shell *H* expands and causes the plate *D* to follow the piston *E* down, and thus open the exhaust *B*, while *H* remains to



A LOCOMOTIVE BELL-RINGER.

keep the steam-port *A* closed. As the bell reaches its lowest point the ring *H* is again forced into the position shown in the engraving, and the admission port is opened to admit a pressure below the piston and give an upward impulse to the bell as it swings in the other direction. The connections are so made that there is no chance for binding, and the bell is free to swing over and over should the upward impulse be sufficient to cause it to do so.

Plans for the New Battleships.—The main features of the plans for the two battleships authorized by the last Congress have been decided upon. Two of the main points were settled by Secretary Herbert himself, and the others were referred by him to the Board of Bureau Chiefs for settlement. The Secretary's decision was contained in a letter which he sent to the Board of Bureau Chiefs. It stated that he had come to the conclusion that double-deck turrets and 13-in. guns were best fitted for the new ships, and referred the question of raising the armor belt 1 ft., as proposed by the Ordnance Bureau, to the Board for settlement. The Board immediately took up the Secretary's letter, and after considerable discussion it was decided to design the ships with the bottom of the belt 5 ft. 6 in. below the water when the draft of the vessel was 25 ft., the extreme draft set by the Secretary. The dimensions of the new battleships are as follows : Length, 368 ft.; beam, extreme, 77 ft. 2 in.; mean draft, 23.50 ft.; extreme draft, 25 ft.; normal displacement, 11,500 tons ; speed, 16 knots, with 1 in. air pressure. The armament for each consists of four 13 in., four 8-in., and sixteen 5-in. rapid fire guns. Regarding the weight to be allowed to the Bureau of Steam Engineering, it was limited by Secretary Herbert in his letter to from 1,000 to 1,200 tons. It was claimed by Chief Naval Constructor Hichborn that 1,000 tons would be all that was necessary to produce 9,500 H.P., the amount required to drive the vessel 16 knots under 1-in. air pressure, the speed wanted by the Secretary.

Engineer-in-Chief Melville, however, says that in order to obtain strong machinery 1,200 tons must be allotted to him. The Board of Construction settled the controversy, in which a compromise was made, the Board deciding to allot 1,100 tons of this department with 10,000 H.P.

Reports of Railroad Accidents.—A committee appointed by the British Board of Trade to report whether any improvement is possible in the shape in which information is supplied by railway companies and tabulated by the Board of Trade has recommended :

1. That the railway companies report to the Board of Trade all fatal accidents occurring in the working of railways, whether to passengers, servants of railway companies, or other persons, by telegraph or otherwise, within twenty-four hours after the occurrence of the accident.

2. That non-fatal accidents be reported to the Board of Trade by post as early as practicable.

3. That non-fatal accidents to servants of railway companies be reported to the Board of Trade whenever they are such as to prevent the servant injured, " on any one of the three working days next after the occurrence of the accident, from being employed for five hours on his ordinary work."

4. That non-fatal accidents to persons other than servants of the companies be in all cases reported to the Board of Trade, as it is impossible to apply the above measure of the gravity of an accident in the case of such persons.

5. That the instructions hitherto given by the Board of Trade to railway companies, as to the classes of accidents to be reported, be withdrawn.

6. That the model form of return issued by the Board of Trade be amended so that the railway companies may be required to state the following additional particulars :

(*a*) The time of day at which the accident occurred ; and where the person killed or injured is a servant of the company ;

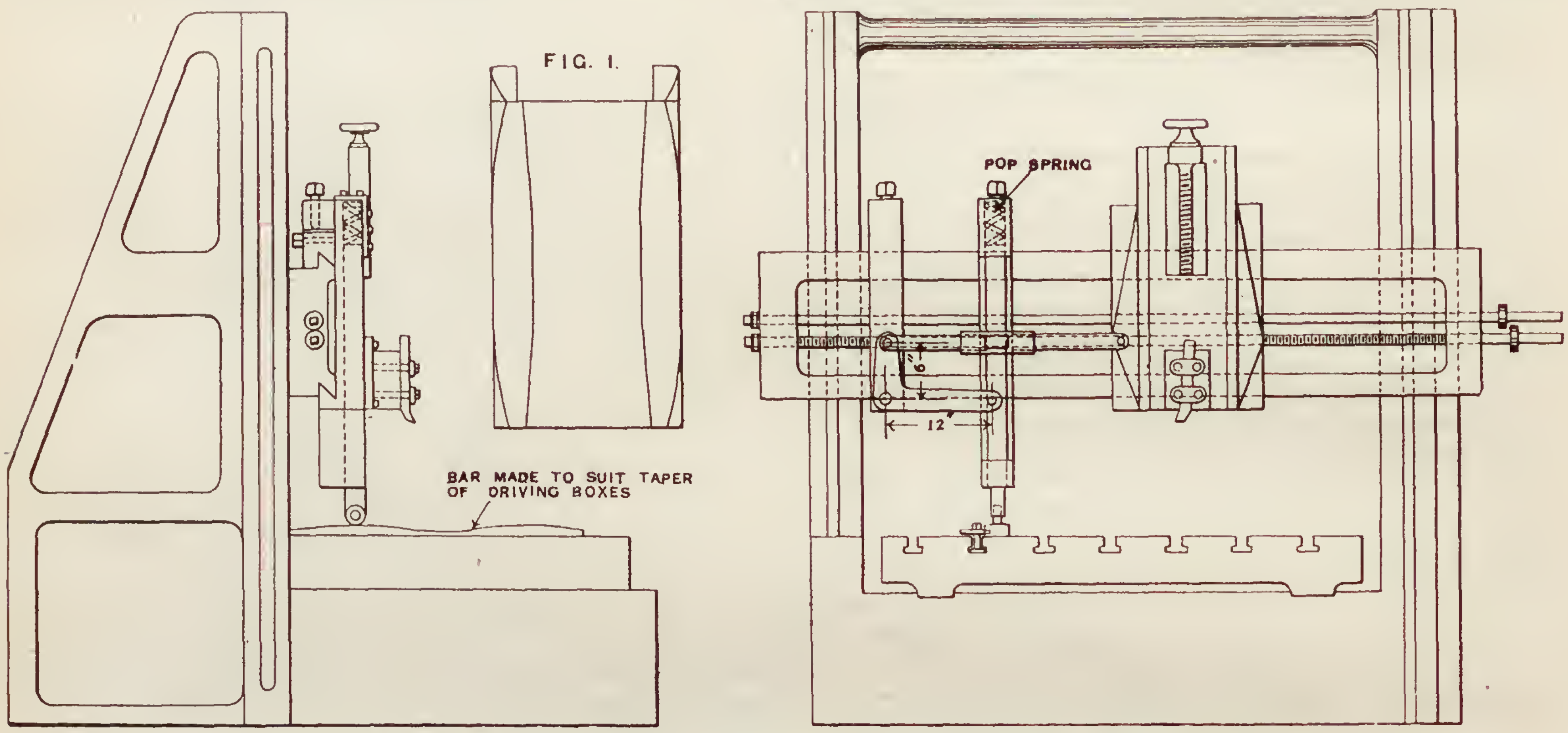
(*b*) Whether he was an adult or a minor (persons of and above eighteen years of age being treated as adults) ;

(*c*) His regular working hours ; and

(*d*) The number of hours he had been on duty when the accident occurred ; and that a note be appended to the form of return requesting the companies to give full and precise descripions of accidents and of the causes of accidents so far as possible.

7. That the railway companies should furnish to the Board of Trade, for publication with the periodical returns of accidents made to Parliament, annual statements of the number of persons employed in each department of their undertakings.

Planer Attachment for Planing the Flanges of Driving-Boxes Taper.—On some roads it is customary to taper both flanges of the driving-boxes of the locomotives on the inside, as shown in fig. 1 of our illustration, in order to allow the box to be down on one side and up on the other without pinching the flanges against the pedestal shoes and wedges. A convenient wrinkle to do this, at one setting of the planer, is in use in the shops of the Baltimore & Ohio Railroad, and is shown by the accompanying engraving. It consists of a template bar bolted to the platen of the planer, upon which there rides a bar having a wheel set in its lower end that is forced down upon the template by the spring at the upper end of the bar. Connected to this upright bar there is a bell-crank, whose other arm is connected to the head of the planer by a rod that has a right and left-hand nut at the centre for adjusting the head and the tool to the work. It will be seen that when the platen of the planer travels back and forth a motion will be imparted to the vertical bar, which is in turn communicated to the head of the planer through the bell-crank connections.



PLANER ATTACHMENT FOR PLANING THE FLANGES OF DRIVING-BOXES TAPER.

Tests of Turrets and Side Armor.—The Navy Department is arranging for an armor test such as has never been made before. The test will be made some time the last part of this month, and is expected to determine as nearly as possible the exact effect produced on a modern turret by the attack of the heaviest guns carried by the new battleships. To effect this test there will be erected on the proving ground at Indian Head a turret such as will be carried by the battleship *Indiana.* This turret is now making at the Cramp Shipyard in Philadelphia.

It will be constructed with all the resisting qualities, backing, and framing which the turrets of the battleship *Indiana* will have when installed. The framework, when completed, will weigh 63 tons. Around this structure will be placed the 18-in. armor plates of the *Indiana's* turrets. One of these plates, however, will be the one which was fired on at Indian Head at the acceptance trials of the *Indiana's* armor. This plate will be used for the attack because of the great cost involved in using a new plate.

The total weight of the turret when mounted on shore will be about 500 tons. It will be a facsimile of a real turret in all respects, save for the absence of the two 12-in. guns. Their weight will be made up by old plates and broken steel, so as to bring the turret up to the weight it would have when installed on shipboard.

When this turret is completed two shots will be fired at the injured plate from the 12 and 13-in. rifles. The department officials expect to be able to determine from this experiment practically what the actual effect produced on such a turret by such an attack in actual battle would be. The experiment will probably result in some valuable lessons in ordnance work, and may lead to improved methods of mounting turrets or strengthening interior parts.

Besides this test, there will be made a test of the resisting power of a ship's side when protected by 15-in. armor. An exact reproduction of a ship's side will be put up on the proving ground. Every beam and rivet will be placed in the experimental side which the ship would have when the armor was in place. This experimental side will be protected by 15 in. Harveyized armor, such as will be placed on the battleship *Iowa*, and the attack will be made by the heavy rifles.

The conditions under which the guns will be fired for these experiments will approximate those which would obtain if the real ships were attacked at a range of about 4,000 yds., or the fighting distance of the contending fleets at the battle of the Yalu.—*New York Sun.*

THE LAVAL STEAM TURBINE.*

By M. K. Sosnowski.

I beg to call your attention once more to this machine, which has passed beyond the realm of a laboratory curiosity and entered the field of industrial appliances. All of the objections that were made to it at the outset, and to which we could only offer our statements to the contrary, have been refuted by actual performances ; all apprehensions and fears have been dissipated by a year's service in France and three years abroad.

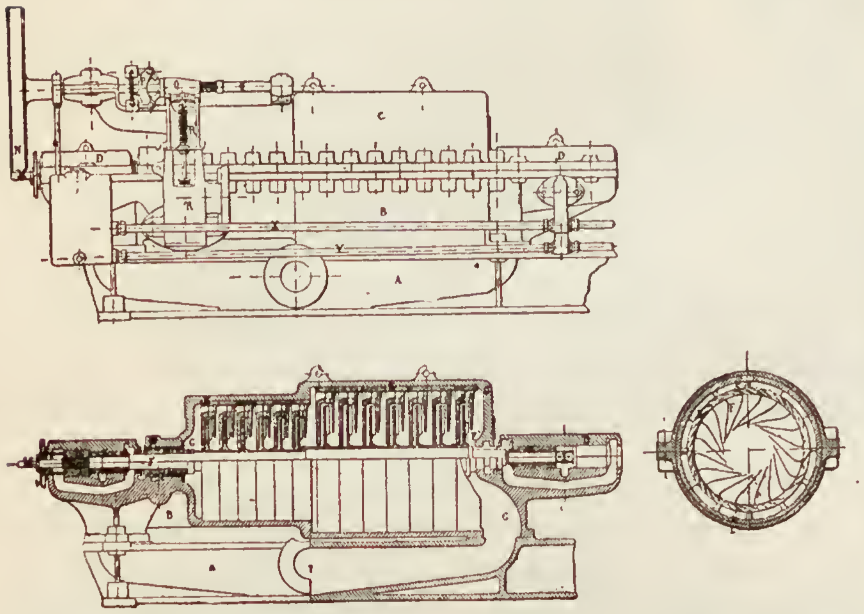


Fig. 1.—ELEVATION, LONGITUDINAL AND CROSS-SECTIONS OF PARSONS' CENTRIFUGAL TURBINE.

It is needless for us to recapitulate the method of utilizing the energy of steam by the use of pistons in the ordinary steam engine, where the motion is rectilinear or rotary. With multiple expansion condensing engines, the maximum economy realizable with this class of motors has been obtained. The actual efficiency is still low on account of transforming the calorie energy into mechanical energy. The losses in efficiency are due to incomplete expansion, to the action of the walls of the cylinder and to other secondary causes which do not permit even the very best steam engines to exceed a third of the theoretical efficiency of the Carnot cycle, which, in its turn, only represents a quarter of the potential energy of the fuel.

In the Laval turbine the two main causes of the low efficiency of piston engines are fortunately quite restricted. We

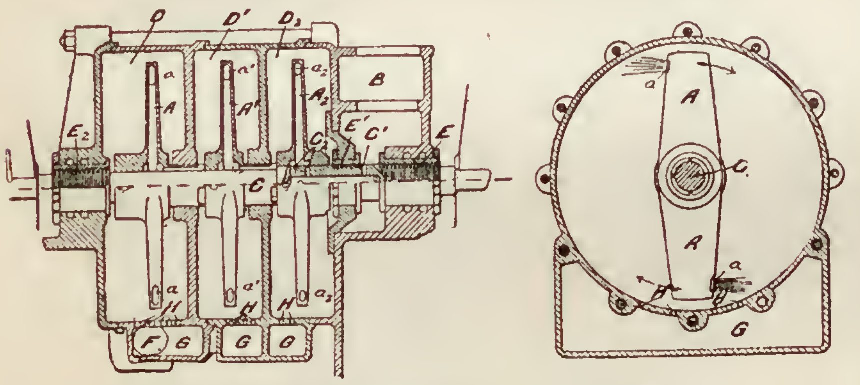


Fig. 3.—PARSONS' REACTING TURBINE.

cannot say that it is the first attempt in this direction, but we can say that it is an attempt that has been crowned with a real success.

Without going too far—for, as in everything else, we can here find very ancient precursors—and without entering too much into details, we will give a brief history of similar apparatus in order that we may better show the difference between the apparatus under consideration and its congeners.

PARSONS' TURBO-MOTOR (1884).

The first Parsons turbines were of the Jouval type, with a circulation parallel to the axis of rotation. They are characterized by the fact that the fall of pressure is not made at once, but takes place gradually in passing through a series of fixed distributors and turbine wheels. It resulted in the necessity of reducing as much as possible the play between the fixed and movable parts, in order to lessen the loss of steam. In the more recent turbines the steam acts radially, either centripetally or centrifugally.

Centripetal Turbine (1890, fig. 1).—The cylinder of the turbine is in two parts, B and C, bolted together. The shaft J', which runs through it, carries a series of movable wheels of different diameters, in order that the expansion may take place on the compound principle, from one series to another. All of them have the radiating wings F. The directors E are fastened to the half cylinders B and C. In order to lessen interior leakages and to compel all the steam to pass through the tur-

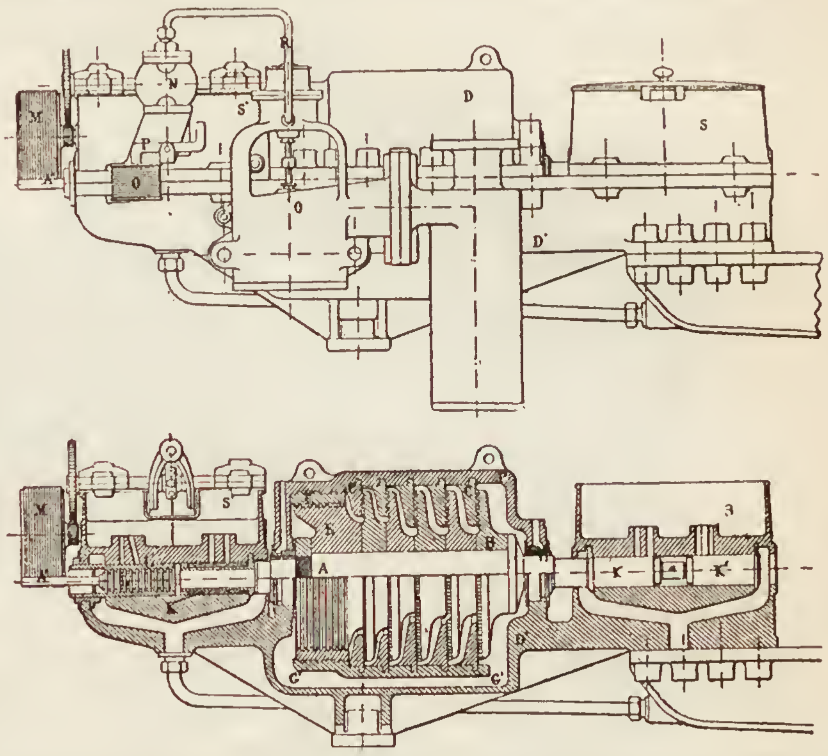


Fig. 2.—ELEVATION AND LONGITUDINAL SECTION OF PARSONS' CENTRIFUGAL TURBINE.

bines, the turning parts are carefully adjusted so as to allow just enough play to avoid frictional resistance.

The steam enters the space G through the regulating valve R, expands against the screen E', traverses the annular space S, comes in contact with the distributors that turn it in a centripetal direction against the other receptacles. From one turbine it passes on to the next, and is thus gradually expanded.

Centrifugal Turbine (1891, fig. 2).—In this type the steam is admitted into the space F. The turbines B keyed upon the shaft A touch each other, and are so designed that their diam-

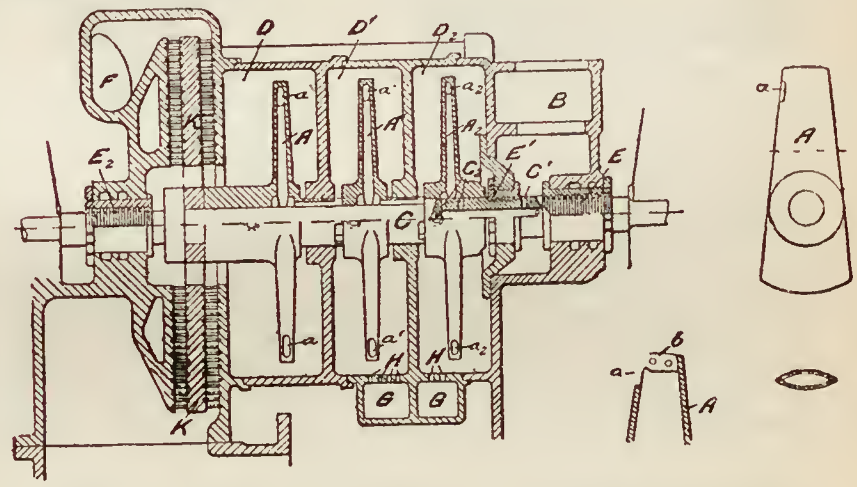


Fig. 4.—DETAILS OF PARSONS' REACTING TURBINE.

eters decrease as we move from the exhaust end. The steam, after having successively passed through the different fixed directors and the first crown C and the wings of the movable disk B, passes from the last circle of B to the first circle of the directors c, and so on, successively expanding, until it escapes into the air or the condenser at a low pressure.

The exhaust G is in communication with the outside face of the piston E. This piston is provided with circular ribs that enter corresponding grooves in the cylinder F, and is so calculated as to almost equalize the thrust of the steam, which tends to separate the disks B from the crowns C. In the last instance the inventor has produced a motor (figs. 3 and 4) which reminds one of the eolipyle of Heron.

The steam (fig. 3) admitted to B enters the first arm A_2 through the holes C^1 and C^2, whence it escapes through the tangential openings a a into the first chamber D_2 ; thence it passes from this chamber by the annular opening cut around the shaft C into the second arm A_1, and so on to the last chamber D, whence it escapes through F either directly or after having exhausted its force on the turbine K (fig. 4). Leakages

* Paper read before the Society of Civil Engineers of France.

of steam around the shaft C are avoided by the grooves $E\,E_2$, and the water of condensation from the chambers $D_1\,D_2$, which accumulates in the pockets G through the holes H. The steam

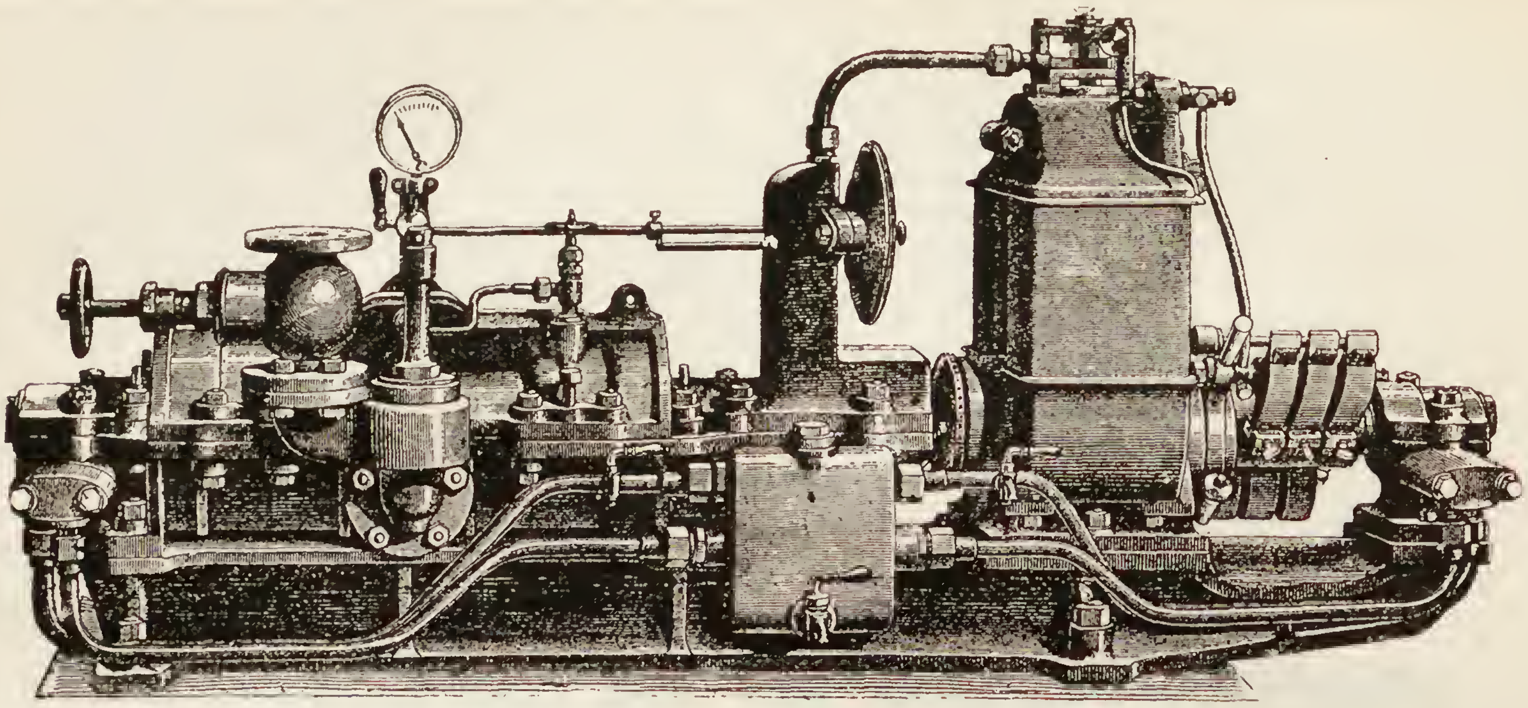


Fig. 5.—PARSONS' TURBINE ELECTRIC GENERATOR.

thus expands from the arm A to the next, and through the successive chambers $D\,D_1$. . . .

Fig. 5 represents a Parsons turbo-electric generator.

DUMOULIN TURBINE (1886).

In figs. 6 and 7 the casing B is keyed to the shaft O, which turns around the disk indicated by double-hatched lines in fig.

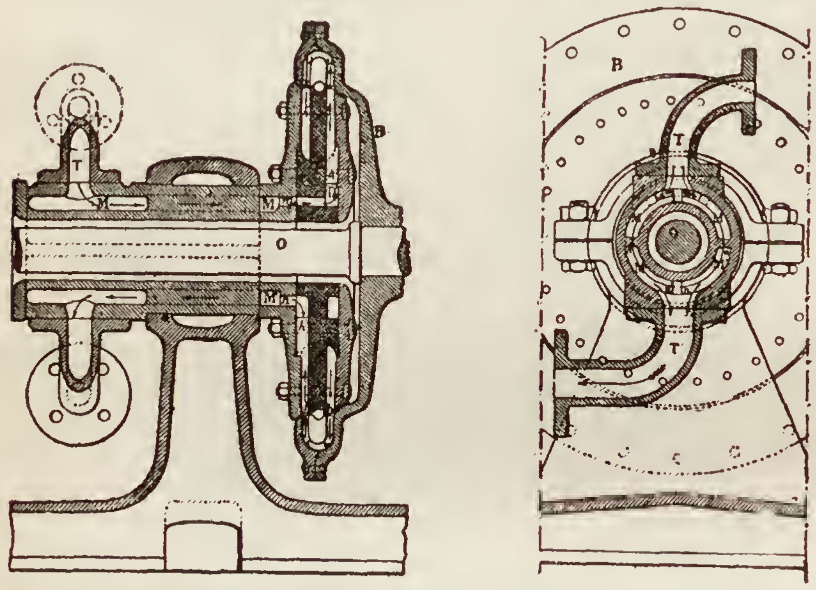


Fig. 6.—LONGITUDINAL AND CROSS-SECTIONS AT THE STEAM AND EXHAUST PIPES OF THE DUMOULIN TURBINE.

6. The whole is divided into four sectors by the admission passages $a\,a'$ and the exhaust $h\,h''$ (fig. 7). In each of these groups the steam admitted at $a\,a''$ by way of $T\,M\,m\,D\,D'$ passes successively from the disk fastened to the crown of the movable casing, thence from this crown to the disk at the exhaust h'', which allows it to pass into the free air or to the condenser after having done its work on the wings $u\,v$ of the crown, and then, having expanded, down to the pressure of the exhaust. The apparatus was designed so as to satisfy as far as possible the conditions indispensable to free movement.

DOW TURBINE (1893).

In figs. 8 and 9 the steam which is admitted at A passes through the openings C_4 in the washers C, and the clearance spaces $i\,i'$ allowed between the faces of these washers and that of the disk F, which is keyed upon the shaft D, enters the wings of the first pair of wheels $E\,E$ and the corresponding directrices of the disks $c\,c_1$ to escape radially into the chamber L, whence it passes to a second pair of receivers, $A^1\,E$, thence to a third, $A^2\,E$, whence the steam finally escapes at M under a very low pressure. The outline of the directors $c\,c'$ and the wings $e\,e'$ is clearly shown in fig. 9. The pressure on the right and the left of the disk F is always equal, for, if the effort to the right is the greater, all of the receptacles move in this direction, and the disk F, striking against the washer C, will close the openings i and open i'. A greater amount of steam will then pass through this side of the system, and thus draw it back into its normal position. It is a centrifugal turbine.

EDWARDS' TURBINE (1892).

This turbine, which is shown in figs. 10 and 11, is composed of a movable disk, 30, between two fixed plates 14 and 15, and turning the shaft by means of the plate 31. Steam is admitted at 10, 11, 12 and 21, between the movable disk and the two fixed disks, and escapes through 33 after having expand-

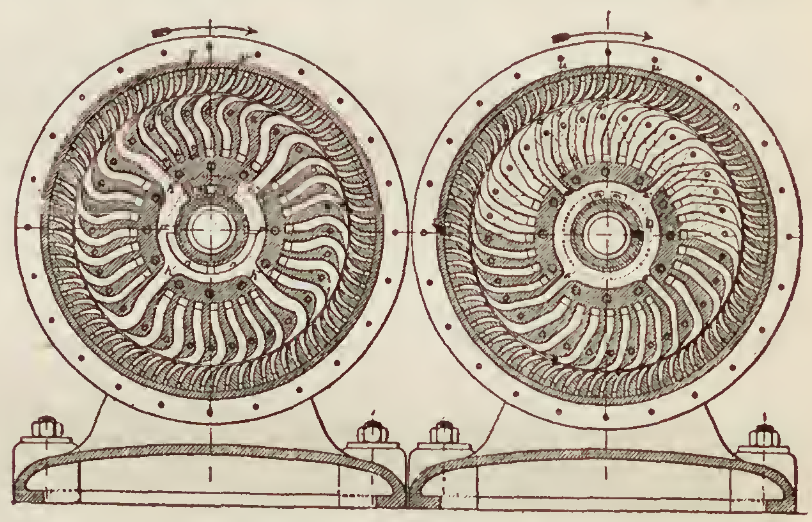


Fig. 7.—VIEW OF THE TWO FACES OF ADMISSION AND EXHAUST FOR THE DUMOULIN TURBINE.

ed between the receiving wings and the directors of the motor. This is also a centrifugal turbine.

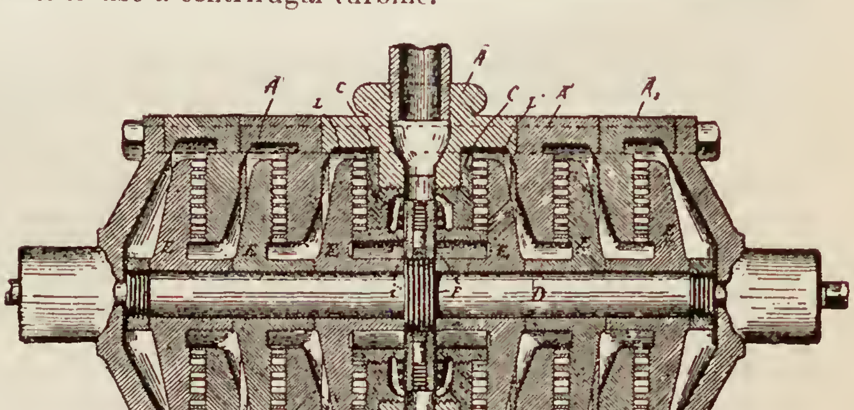


Fig. 8.—LONGITUDINAL SECTION OF THE DOW TURBINE.

The play between the motor disk and the plates is about three one thousandths of an inch, and it can be adjusted with great precision by the vernier 40 (fig. 11) that is cut upon the plates 14 and 15.

MᶜELROY TURBINE (1893).

In this turbine (fig. 12) the steam follows a centripetal course. Admitted at *J H* around the motor disk *A*, it escapes from the centre at *G* through *g g*, after having run through the spiroidal passages *K* in the plates *F*, which are enlarged

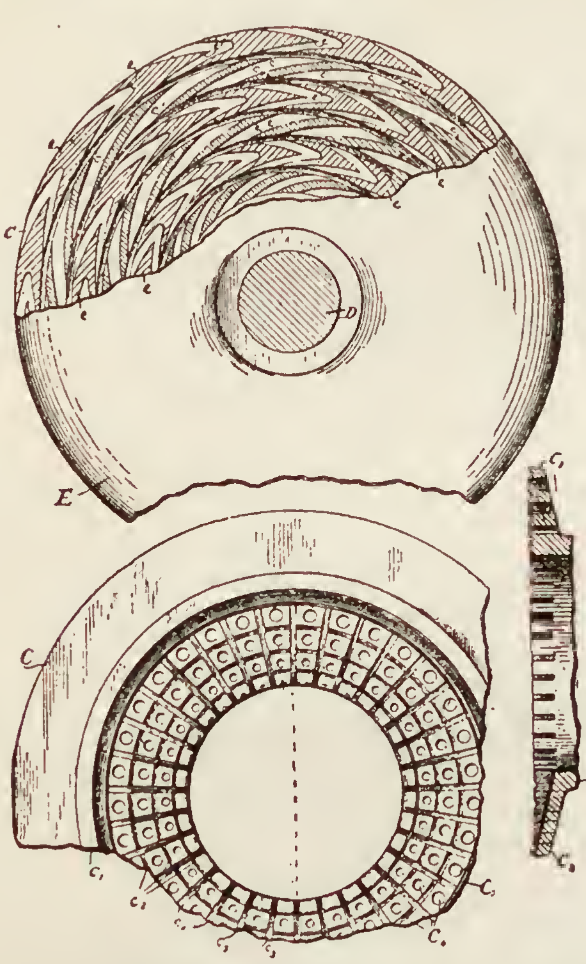


Fig. 9.—CROSS-SECTION OF THE DOW TURBINE.

toward the centre so as to allow the steam to expand at the same time that it acts upon the wings of the disk *A*.

SEGER TURBINE (1893).

This turbine (fig. 13) consists of two wheels, *a* and *b*, joined by pinions so as to turn at the same speed, but in opposite directions. They are enclosed in a chamber whence the steam

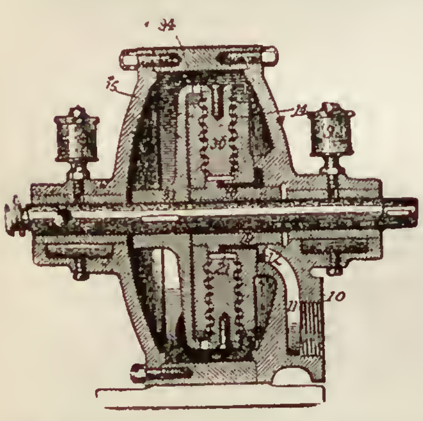


Fig. 10.—LONGITUDINAL SECTION OF THE EDWARDS' TURBINE.

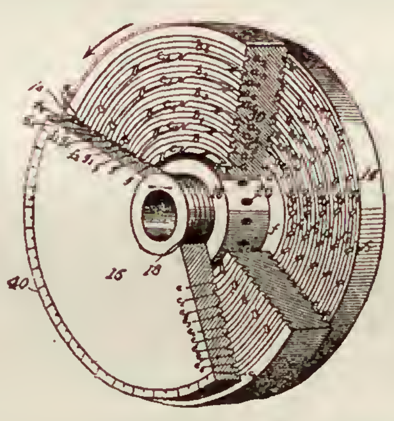


Fig. 11.—DETAILS OF THE DISKS OF THE EDWARDS' TURBINE.

escapes after having passed from *c* into *a* and *b* through the wings of these two wheels, which receive it. We merely mention this turbine, which never seems to have seen the light of day, and whose efficiency was only very moderate.

As will have been remarked, all of these machines utilize the pressure of the steam while working in tight compartments and turning at high velocities. The play of three one-thousandths of an inch can be obtained, but it will be difficult to maintain it under working conditions, so that the leakage will grow greater and greater and the utilization of the pressure of the steam will become more and more defective.

(TO BE CONTINUED.)

MACHINE DRIVING WITH ELECTRIC MOTORS.

In a paper read before the American Institute of Electrical Engineers at Niagara Falls, by Messrs. F. B. Crocker, V. M. Benedikt, and A. F. Ormsbee, after instancing several cases where electric motors have been successfully introduced for the driving of machines, they sum up with the following conclusions :

First Cost.—Practically the only objection which can be urged against the electric system is the fact that the first cost of installation is greater than with ordinary belting and shafting, but even this is questionable, since the authors know of cases in which the estimated total cost of installing the necessary belting and shafting was actually greater than the equivalent electric motor outfit. The electric system would be

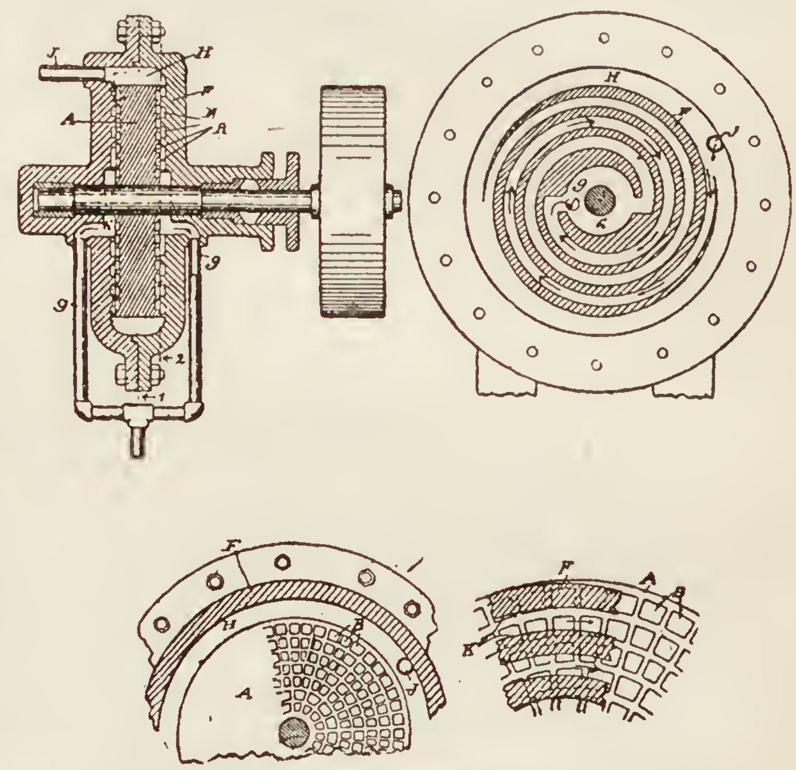


Fig. 12.—DETAILS OF THE MacELROY TURBINE.

cheaper, for example, in the case of very long or scattered buildings or those containing many stories or rooms, in any of which cases the belting and shafting required would be very complicated and expensive. The use of belting and shafting requires a much stronger and more expensive roof or ceiling than the electric system.

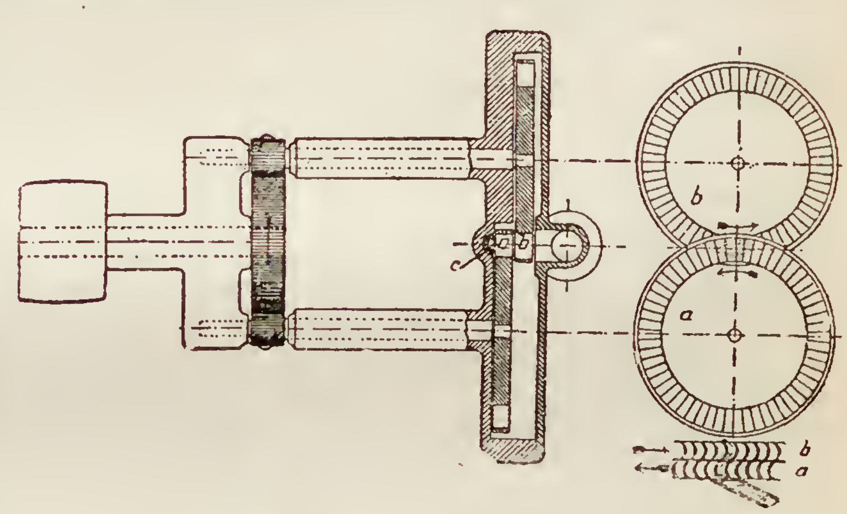


Fig. 13.—DETAILS OF THE SEGER TURBINE.

Saving of Power.—It might seem that the electric system would actually consume more power than the ordinary plan, since it involves two transformations of energy. In most cases, however, if the power has to be distributed to a number of machines, particularly if they are located at any distance from the engine, the loss of power is less with electric transmission. This is explained by the high efficiency of the dynamo and motor compared with the low efficiency of belt transmission as ordinarily practised, involving as it often does very imperfect alignment and lubrication of the shafting. Perhaps the greatest saving, however, of the electric system is due to the fact that the consumption of energy entirely ceases when the tool stops. This stoppage in the case of the busiest tools amounts to at least 25 per cent. of the nominal working hours throughout the year, and with large or special tools which are not used so steadily the stoppage is often as high as 50 to 75 per cent., since there are many whole days when they are not used at all.

Idleness due to strikes as well as to slack times must also be considered, and would usually amount to quite a large percentage in ten years, for example. This assumes, of course,

that a portion of the shop is running, which is usually the case even under such conditions. In short, with the mechanical system there is an enormous amount of shafting, idle pulleys, and belting which runs for long periods of time doing little or no useful work, but consuming considerable power.

Wherever electric motors can be substituted for a number of small engines scattered about, the saving in power is very great, not only because of the low efficiency of small steam-engines, but also by the avoidance of condensation in long steam pipes.

Increased Output.—This is, perhaps, the most important advantage gained by the electric system, since after all the cost of power is a very small item, being, according to Mr. Richmond, only about 1 per cent. of the wages paid in average machine-shop practice.

This increased output is secured by greater convenience and promptness in starting and stopping as well as in regulating the speed of the machinery. The workman can, for example, temporarily increase the speed when the conditions are favorable, thereby saving considerable time.

Flexibility.—The great convenience of moving the tools and placing them in any desired position is another great advantage of the new system. The great adaptability of this system is particularly well shown in the case of a factory which was almost completely destroyed by fire, nevertheless a few uninjured tools in a remote end of the building were operated successfully by means of electric motors within two days after the fire.

Speed Regulation.—The ordinary type of motor used in factories is the plain shunt wound machine fed with constant potential current. The motor is started and varied in speed by means of a rheostat in the armature circuit. This simple arrangement answers very well in most cases, but for variable speed between wide limits a series wound motor controlled by a rheostat as in railway practice may be preferable. In other cases some special method of regulation, such as the Leonard system, or the "boost and retard" plan may be adopted.

AMONG THE SHOPS.

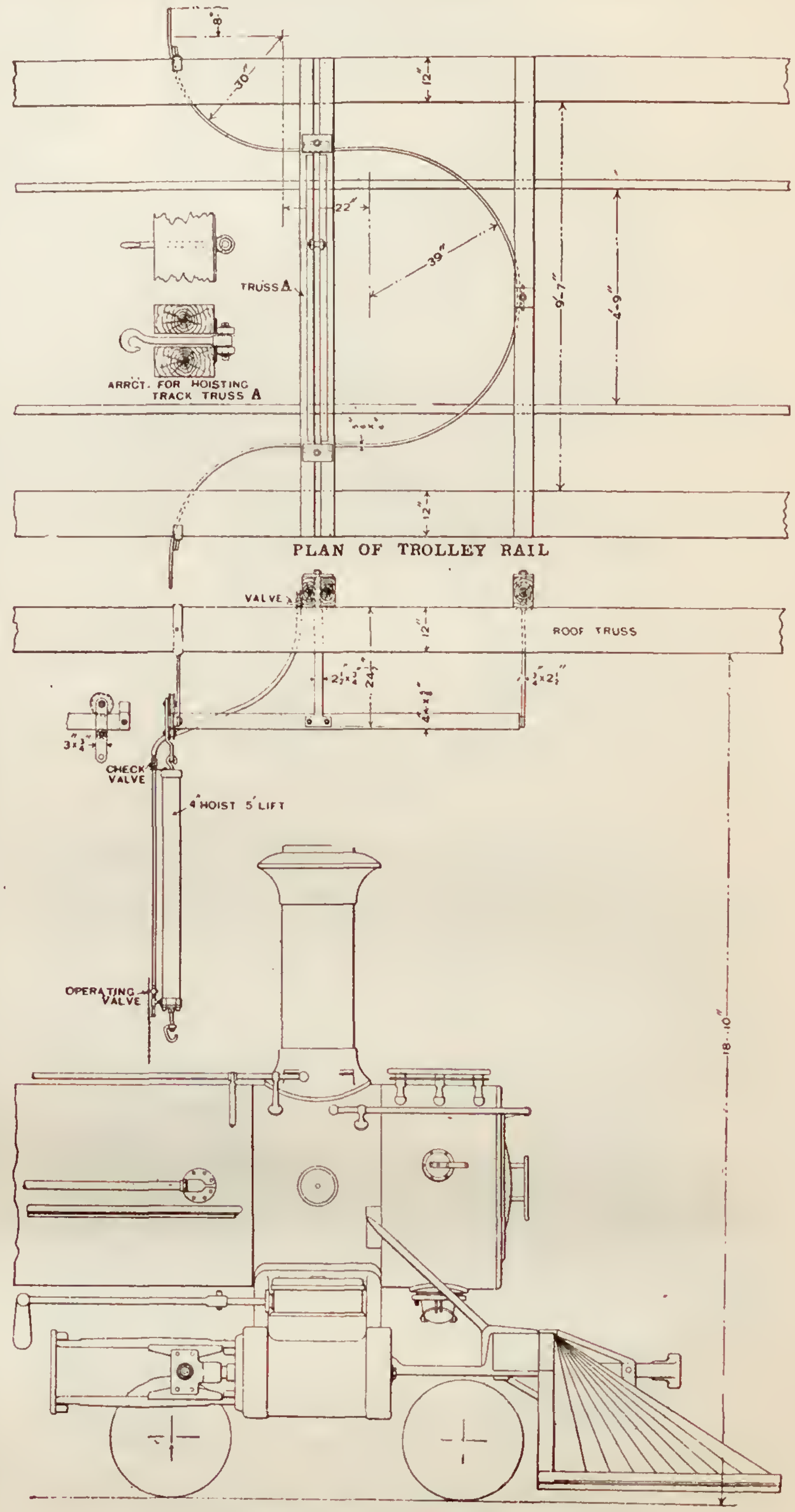
WEST PHILADELPHIA.

They say that the hard times of the past two years have had a tendency to develop the latent inventive talents of the master mechanics in charge of the shops of the railroads of the country, in that their allowance for expenses have been cut down, while the amount of work required has by no means fallen off in anything like proportion to the cutting down of the said allowance. Whether this be true or not of the West Philadelphia shops of the Pennsylvania Railroad, it certainly is a fact that they have some mighty interesting little wrinkles at work there, and which have so established themselves in favor with all hands, that they are now considered indispensable. Of course they are up to the times in the matter of the introduction of compressed air for all manner of purposes, as our readers will see if they take the pains to go through this article.

There is nothing new in the application of compressed air to hoists, but they have a novel application to a drill press that is, we think, original in these shops. Drilling holes with a hand feed is slow, and is apt to become slower and slower as the day goes by and the apprentice becomes interested in the probable results of the afternoon's game of ball. To obviate such loss of time, the table of a small drill has been fitted with a plunger that fits into a cylinder that is, in turn, connected with the compressed-air pipes. The piece to be drilled is placed on the table, the air is turned on, the table rises with a constant and continuous pressure and forces the metal against the drill. The feed or pressure is proportioned to the capacity of the drill to cut, and the work is done in the shortest possible time, regardless of the fact as to whether the pitcher of the home team is in good form or not.

At the track where wheels are removed from and put under the engines there are two heavy jacks used for raising the locomotives. The heads of these jacks are fitted to receive the cross-bar upon which the engine rests, and the whole is of such a weight that the adjustment takes more time than should be consumed in doing the work. To save time at this point, an overhead track has been put up, and from a couple of trolleys running on them there hang two rods fitted with turnbuckles by which the jacks can be lifted from the floor and run along the side of the engine to the point where it is desired to use them. Then, in order to avoid the heavy straining and delays incident to lining the wheels and getting them upon the track over which the engine is standing, there is a ram in the floor just beyond the end of the engine which is used to lift the wheels from the floor while they are swung around into line. This ram is operated by compressed air.

Every man who has had to do with locomotive repairing has been troubled to a greater or less extent by the inadequacy of the means of handling the heavy parts that must be removed even in cases where only partial repairs are made. At West Philadelphia there is an air hoist rigged around the front end



AIR HOIST FOR LOCOMOTIVE PITS.

of every pit in the repair shop. The form of this track is clearly shown in the engraving, and it will be seen that with the hoist travelling over this track everything on and about the front end of the locomotive can be lifted and lowered to the floor, thus doing away with the necessity for a large gang of laborers, whose sole duty is to tire themselves and every one else with their heavy lifting. In order to handle the other parts that are located further back and out of reach of this hoist, such as the dome caps, air pumps, etc., there is another track that is pivoted over the back end of the cab, and which itself travels on a trolley running on a circular track just back of the stack. On this track there is a chain hoist that can be made to cover all of the back end of the engine; and, after the part to be removed is swung free, it is run forward and brought out far enough to clear the engine and lowered to the floor. Thus the man doing the work, with the assistance of a single helper, can take down any part of an engine and replace it, and that, too, without any very great exertion, and certainly without making a fuss about it.

The same idea has been carried out in the blacksmith shop, where the heavy forms for the steam hammers are kept on a floor outside of the building. An overhead track runs from the two hammers, where a variety of forms are used out through the door where there is a switch, and turning passes over the place where the forms are kept. On this track there is an air hoist which can be made to pick up the form and carry it to the hammer and put it in place without the men doing the work being compelled to do any lifting at all. The objection to the use of air where the hoist is to be moved for any distance that an inconvenient length of hose must be used is overcome in this instance by having an air connection at each of the hammers and a length of stationary hose at each of the storage places sufficient to reach the hoist wherever it may be standing, and then equipping the latter with an air-brake coupling, which permits the connection to be made and the load lifted. Then the connection is broken and the load carried to the point where it is to be lowered, and a new connection made to do the proper adjusting. This certainly solves the problem where the load is always handled at given points within the range of lengths of hose of moderate lengths.

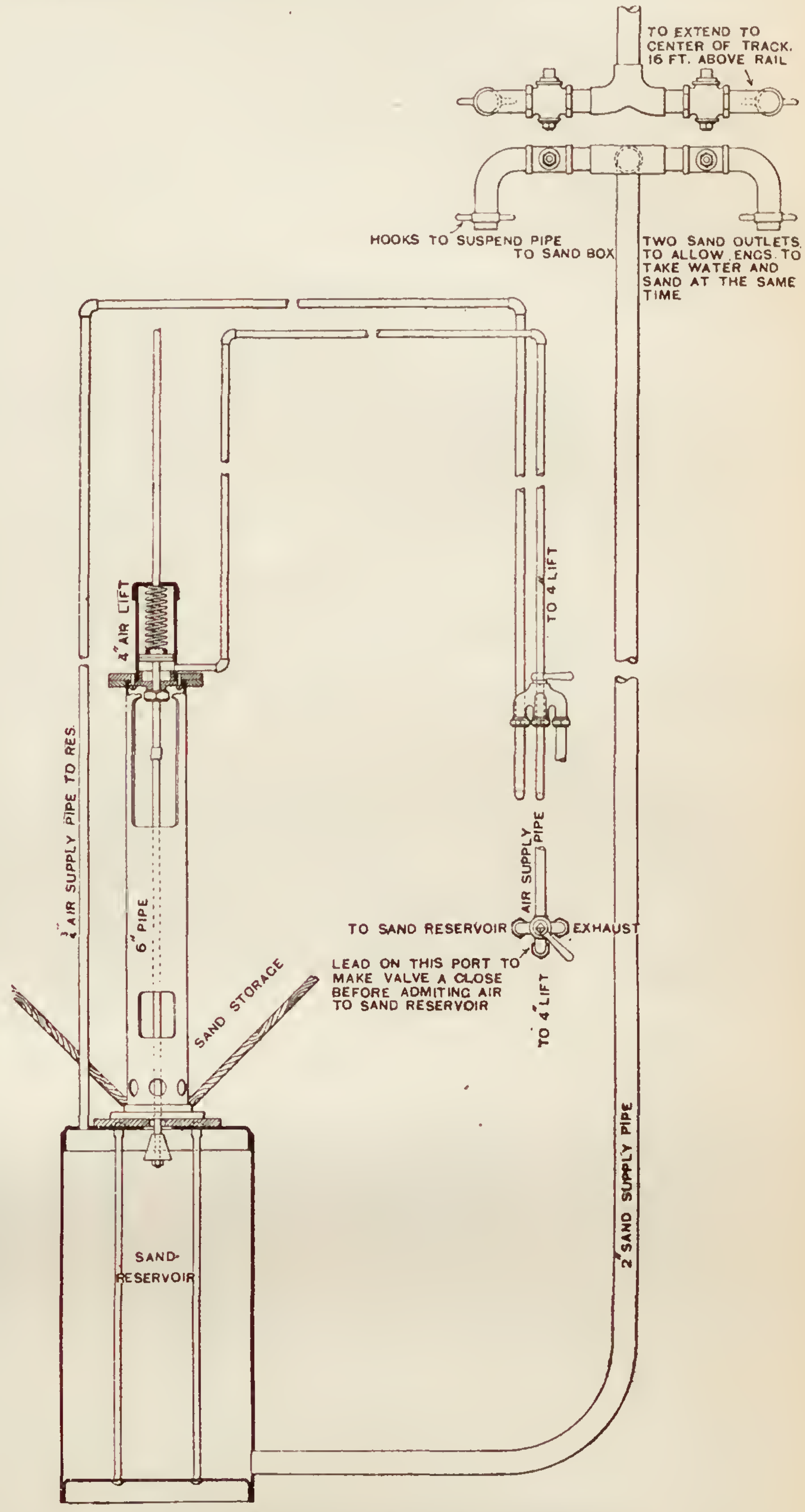
Before leaving the blacksmith shop we wish to call attention to a wrinkle that saves lots of trouble and more expense. Here there are two special forges that are used for doing overtime work, and which are fitted to be blown by compressed air taken from the pipes that supply the shops and the hoists. As this air is drawn from the mains that supply the air for the signals in the Philadelphia yard, it is always present; and no matter when there is a call for overtime work, these forges are ready. In ordinary working they use the air from the blower the same as the other fires in the room, as this is cheaper than the compressed air; but the latter comes at the lower price when a single fire is wanted, and it would be necessary to run the whole shop in order to keep the blower in motion.

To those who are familiar with the shot-gun feed that is used in the saw-mills of the Northwest for moving the carriages of circular saws, a handy adaptation of the same will be found in these shops. There is an air hoist travelling on an overhead track for swinging driving-wheels into the lathe. As pushing them by hand is more or less difficult, and is always accompanied by a certain amount of swinging, a long cylinder is bolted to the ceiling, and in this there is a piston and rod, the outer end of the latter taking hold of the trolley carrying the hoist. Thus, by admitting compressed air to one side or the other of the piston, it is moved in or out and the load conveyed to the point desired. It is so simple that it would not attract attention but for the extreme handiness of the device. This long cylinder has, of course, a piston stroke equal to the total travel of the trolley.

As the Light Brigade are said to have found cannon on all sides of them, so in the West Philadelphia shops compressed air seems to be used for every conceivable purpose. One of these appliances is shown by the engraving, where it is represented as lifting the dry sand for the locomotive's from the bin to the sand-box on the boiler. It is automatic in its action other than the necessary handling of the three-way cock that is outside of the building. Beneath the bin for the storage of the sand there is a cylindrical vessel called the sand reservoir. When not in use, the valve shown at the top of this reservoir is down and open, as in the engraving. The pipe which rises from the top of the reservoir has holes cut in the shell, as shown, and through these holes the sand flows down into the reservoir until the latter is filled, and this is enough to fill a sand-box on an engine. When an engine is to be sanded, the handle of the three-way cock is turned, and as it is moved it first, by reason of the lead that is given to the valve, admits air into the pipe leading to the 4-in. lift. The result of this is that the piston in this lift or cylinder is forced up, thus closing the valve at the top of the sand reservoir. As the handle moves further, it opens and admits air into the ¾-in. supply pipe to the reservoir. Then, when the valves at *X X* are opened, the compressed air rushes out and carries the sand with it, the latter falling into the sand-box on the locomotive, whose opening is directly underneath. As soon as the box is filled the valves at *X X* are closed and the three-way cock also, when the valve at the top of the reservoir drops into the position shown, and the sand again flows down to take the place of that which has been removed.

It is barely possible that Diogenes was mistaken in the honest man that, after a long search, he finally decided he had discovered, and so it may be that we are mistaken in thinking that we have found the best method of flue welding that exists. We have been looking for a long time for a flue-welding plant that we could recommend in all of its particulars, but there has always been some drawback in the tools used or in their arrangement that left the plant open to criticism. Either something would be wanting, or the flues would need more handling than a specification for an ideal system would permit, or they would not travel in a direct course from start to finish, or there would be an obstruction in the way. At any rate, we have not seen what we were looking for until that in use in the West Philadelphia shops was happened upon.

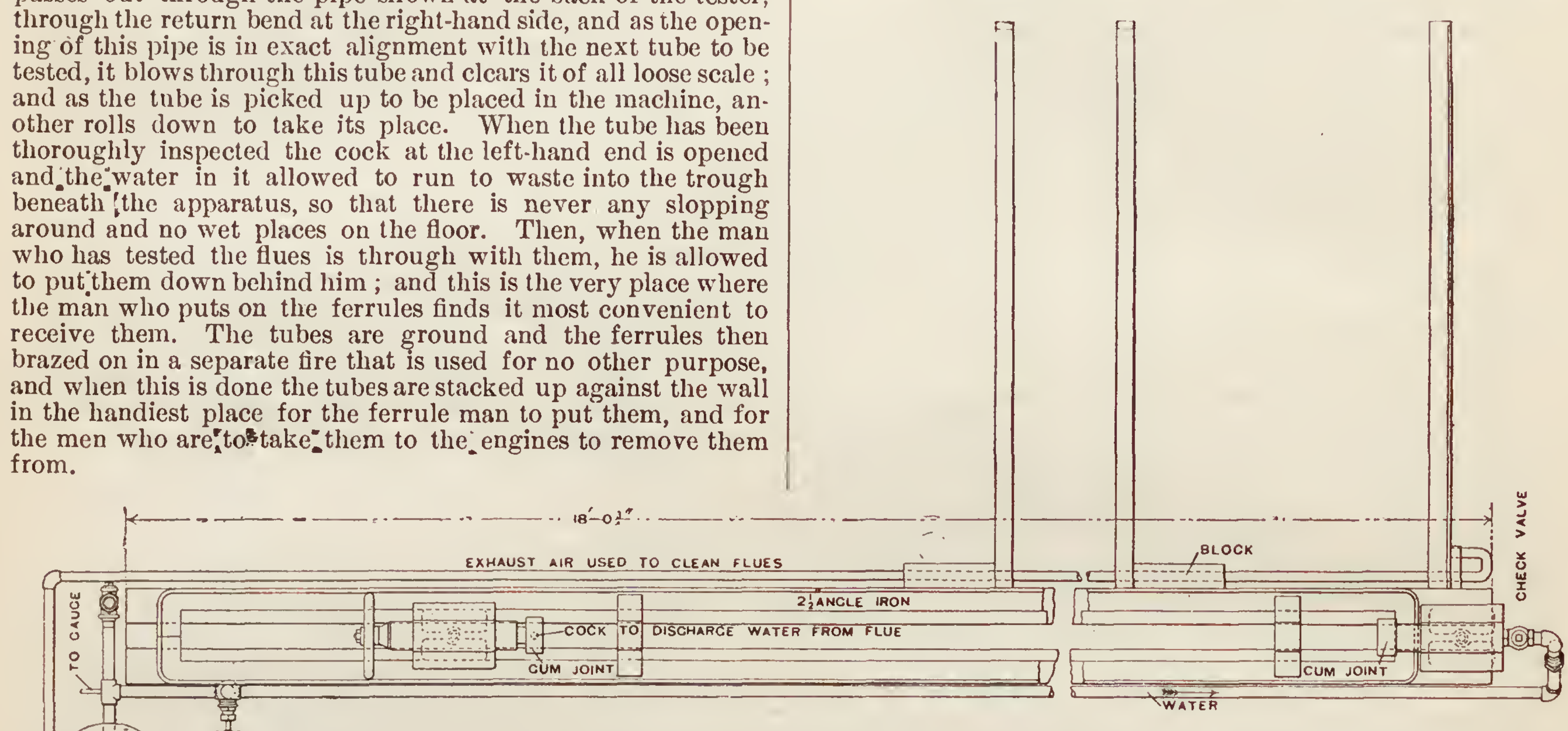
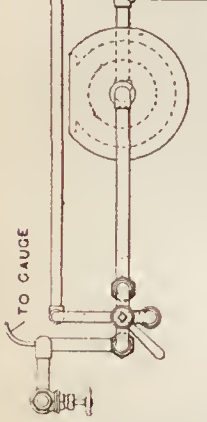
One side of a small shop is devoted to this work. At one end there is the rattler, boxed and protected so that no dust escapes into the shop, and the noise that is heard is reduced to



COMPRESSED AIR SAND-LIFTER.

a minimum. Immediately at the side of the rattler is the lathe where the tubes are cut and scarfed. Here there is a little wrinkle in the shape of a conical bearing that holds the tube central while the scarfing is being done, and prevents any uneven work on the part of the tool. Just beyond this lathe there is the forge for welding, so that the handiest place for the scarfer to put the tubes is also the handiest place from which the welder can pick them up to place them in the fire. Beside the forge there is a welding machine very if not exactly similar to the beading machine illustrated in our issue for May of this year. One step, therefore, takes the smith from the forge to the welder, and the tube is again dropped in the handiest place for the man whose work upon it is finished. This happens to be an incline like the log incline of a saw-mill, and leads down to the testing apparatus shown in the accompanying engraving.

In some respects this is like all of the other flue testers that are in use in the hundreds of shops in the country, except that it goes a step farther than any of them, and is neater, handier and more efficient than any other that we have seen. As Beau Brummel said of the wonderful cravat that is reported to have cost the prince so many sleepless nights, "Starch is the man." So here we can say, "Compressed air is the man." The tube is put in the machine and the ends tightened in the same way that it is done in the machines with which all are familiar; water from the city mains is turned on until the tube is filled and all of the air is out. Then air is turned on, and, entering the top of the larger cylinder shown in the end elevation, forces the smaller piston in the lower cylinder down upon the body of water beneath, increasing the pressure per square inch, and thus acting upon the interior of the tube. All of the disagreeable and laborious hand pumping is thus done away with, and the man has an opportunity to inspect the work. If there is no leak the air is shut off and exhausted, and here comes in the fine work. The old way of lifting a tube up on end and giving it one or more thumps on the ground to clear it from scale is avoided. The exhaust air from the upper cylinder passes out through the pipe shown at the back of the tester, through the return bend at the right-hand side, and as the opening of this pipe is in exact alignment with the next tube to be tested, it blows through this tube and clears it of all loose scale; and as the tube is picked up to be placed in the machine, another rolls down to take its place. When the tube has been thoroughly inspected the cock at the left-hand end is opened and the water in it allowed to run to waste into the trough beneath the apparatus, so that there is never any slopping around and no wet places on the floor. Then, when the man who has tested the flues is through with them, he is allowed to put them down behind him; and this is the very place where the man who puts on the ferrules finds it most convenient to receive them. The tubes are ground and the ferrules then brazed on in a separate fire that is used for no other purpose, and when this is done the tubes are stacked up against the wall in the handiest place for the ferrule man to put them, and for the men who are to take them to the engines to remove them from.

PLAN OF FLUE-TESTING APPARATUS IN USE IN THE WEST PHILADELPHIA SHOPS OF THE PENNSYLVANIA RAILROAD.

There may be better flue-welding plants than this in operation, but we have never seen them; still, if any of our readers know of a more convenient or efficient arrangement, they will be doing us a great favor to call our attention to it, and we will do our best to give this superlative apparatus all of the publicity that it deserves.

THE UNITED STATES CRUISERS "COLUMBIA" AND "MINNEAPOLIS."

In previous issues* of this journal we have published very complete descriptions of the hull and machinery of the two United States armored cruisers, the *Columbia* and the *Minneapolis*. At the time of the publication of the accounts of these vessels they were in course of construction, and the only illustrations available were those taken from the drawings of the Navy Department. Now, however, that the vessels are in commission, photographs of them have been taken, two of which we reproduce on pages 412 and 413. It will be seen, on comparing that of the *Columbia* with the one published in our issue for October, 1890, that the design has been slightly modified by a rearrangement of the boilers, whereby the vessel has four smokestacks instead of three. The *Minneapolis* is a sister ship to the *Columbia*, but a further rearrangement of boilers put two stacks upon her. With the exception of these slight modifications in detail the vessels are the same in structure, armament, engines and boilers.

Probably no two vessels have ever been added to any navy that have attracted more attention than these. While they were still officially known as cruisers Nos. 12 and 13, they were nicknamed the "Pirates," because of their avowed purpose of being able to fill in the navy of the United States the place occupied by the *Alabama* in the navy of the Confederacy. They were built to be commerce destroyers, and with their guaranteed speed of 21 knots, which became 23.07 knots on the official trial of the *Minneapolis*, and 22.8 knots in the case of the *Columbia*, it was acknowledged by experts upon both sides of the Atlantic that they could overhaul and destroy any vessel of their size afloat. They excited an interest aside from the speed which they were expected to attain and which they exceeded, in that they presented an innovation in the engines and screws that was without a parallel.

Triple screws had been tried before, but upon smaller vessels; and while the results obtained were far from satisfactory, it was not considered to be proven, except by a few croakers, that the arrangement on the new cruisers would not be successful. Experts recognized that consummate skill had located the three screws, and it was only feared, not predicted, that the water in which the centre screw worked would not be solid. The trial trips and the service at sea seem to have so settled this matter that we hear no more about it, and the triple screw is acknowledged to be a success. Indeed, any other conclusion would be impossible to reach when we note the gain of 11.9 per cent. in the economy of propulsion of the triple screws over the twin screws as compared with the cruiser *New York*.

It is needless to recapitulate the details of the vessels, which are very fully given in the issues to which we have already referred; but it will be interesting to note one of the recent performances of the *Columbia*.

It must be remembered that these cruisers are not intended to fight heavily armored battleships, but to catch and cripple the fast vessels of an enemy's mercantile marine. They are, therefore, built with a large coal capacity, and are engined so as to be economical in the use of fuel at all rates of steaming.

The total coal capacity is very large, reaching 2,000 tons; at 10 knots speed per hour this will give the vessel an endurance of 50 days, or a radius of action of 12,000 nautical miles, or sufficient to go half around the world.

We cannot do better than quote the remarks of Mr. Biles, at the time of the launching of the *Columbia*, regarding the special mission of these sister ships to overtake and destroy: "The commerce destroyer is about the same length as the 17 and 18-knot merchant mail steamers, and no doubt could very easily overhaul any vessel of her own length in almost any

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* American Engineer and Railroad Journal, October, 1890; December, 1890; September, 1892; September, 1893, and December, 1894.

weather; but even though she may have a sustained sea speed in moderate weather of 21 knots, it is very doubtful whether, in average Atlantic weather, she could catch such vessels as the *Teutonic* and *City of Paris*, for their extra length is considerably over 100 ft., and their extra weight, which would be nearly double, would inevitably tell in a seaway. It is further doubtful whether the bow of this vessel above water is, either in shape or height, well adapted for driving against a head sea at such a high speed. Her freeboard forward is 19½ ft., which is low as compared with the *City of Paris*—32 ft. It is not very apparent what is gained by having a long projecting underwater stem in such a vessel. To use it would be to cripple herself in the quality for which everything has been sacrificed—namely, speed. A straight stem, like most merchant ships have, but with considerable flare out, would probably improve her speed in a head sea, and would certainly keep her drier forward. For continuous steaming at high speeds the well-tried mail steamer would be more efficient. It would be quite easy to arrange in the design of mail steamers intended to act as commerce destroyers that structural framing, shaped and situated like a protective deck, should be fitted, on which in time of war thick plates could be laid and secured."

Whether or no there has been any driving of the *Columbia* against a head sea, whereby the strictures of Mr. Biles regarding the low freeboard forward have been disproved or substantiated, we have been unable to learn, but the probability is that no such trial has ever been made. The only attempt that has been made to drive the vessel at a high speed for a long distance occurred on a recent voyage from Southampton, England, to New York, when the ship was returning from the Kiel festivities incident to the opening of the Baltic and North Sea Canal.

The record of this voyage is briefly as follows:

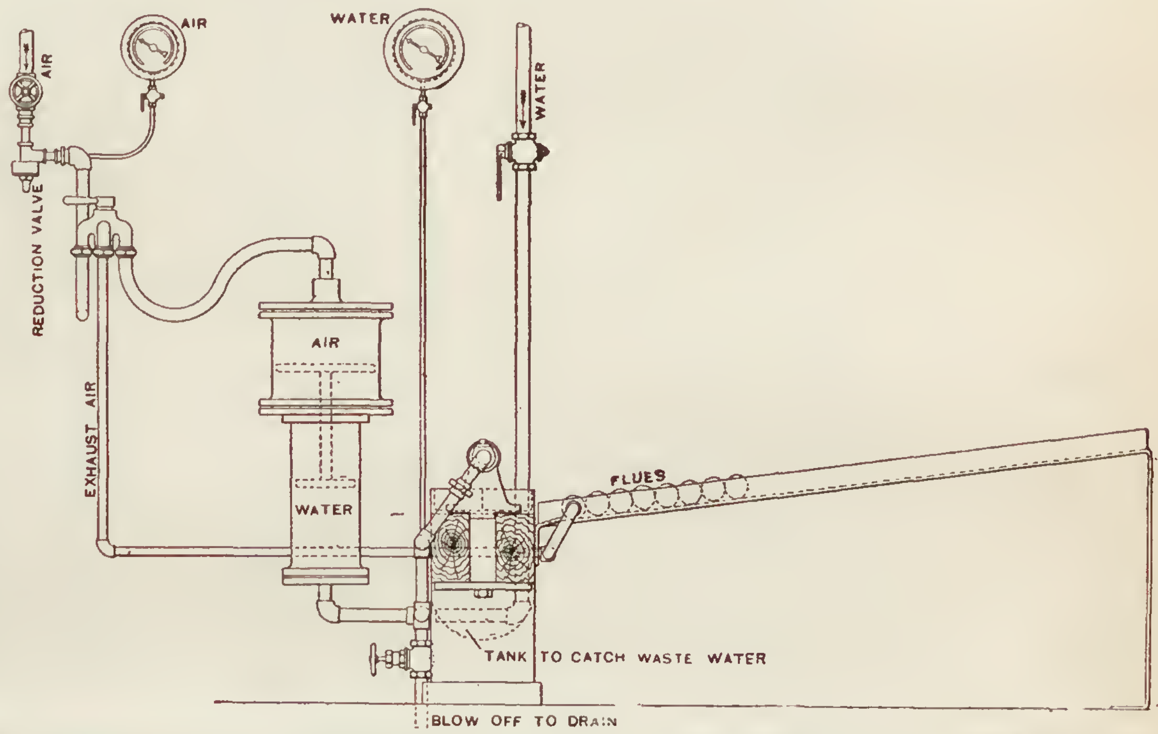
The *Columbia* left Southampton on July 26, having on board 1,973 tons of coal, filling the bunkers and utilizing the wing passages and fire rooms, and even the decks, where 40 tons were stowed away under the superstructure. With this load the vessel drew 26 ft. 4 in. forward and 25 ft. 7 in. aft—an unfortunate trim, but unavoidable. The fire-room force was 12 short, and that number was made up by volunteers from the deck force, and three petty officers were transferred to the engineers' department to assist in carrying coal. It was intended to speed the vessel under forced draft for the last 24 hours of the voyage, but this was abandoned as impracticable, for while there were 300 tons of coal left, it was at the ends, and could not be moved sufficiently fast to feed the fires for such a test. The coal was the best obtainable at Southampton, and of the quality used by the American Line.

Under these conditions the *Columbia* passed the Needles at two P.M. on July 26, and made the run to Sandy Hook Lightship in six days, 23 hours, and 49 minutes, covering 3,112 nautical miles at an average speed of 18.53 knots an hour, and placing to her credit, we believe, the best long-distance run ever made by a warship. The schedule of her daily runs, as taken from the ship's log at noon of each day, is: 405, 487, 470, 457, 455, 453, and 405, the last being taken upon her arrival at the Sandy Hook Lightship at eight o'clock on the morning of August 2.

An interesting comparison may be made with the run of the *Augusta Victoria*, of the Hamburg-American Line, which came over at the same time, arriving at the Lightship two and one-half hours behind the *Columbia*. The distance covered by this vessel was 3,054 nautical miles, and it was traversed in six days, 20 hours and 20 minutes, the average speed being 18 54 knots, or .01 knot faster than the *Columbia*. Thus it appears that the cruiser can be driven at the same speed as that at which an express passenger steamer is run on an ordinary passage, but that .01 knot is sufficient to give safety to the latter in the case of a stern chase. Undoubtedly the *Columbia*, with her forced draft, could do decidedly better than the 18 53 knots of the present record; and it is claimed by some of the engineers of the Navy that the *Minneapolis* can do still better; but this remains to be seen. As for the coal consumption, a test was made with the *Columbia* some time ago, in which, on a six-hour test, the following results were obtained:

No. of Screws Used.	Speed in Knots.	Coal Burned Per Day.
3	16.41	125.6 tons.
1	10.06	38 3 "
3	18.04	223.0 "
2	13.36	70.2 "

As far as the investigations have been carried it may be considered that these pirates, or commerce destroyers, or cruisers have fully met the expectations and intentions of their designers. It has been shown that for a burst of speed they can run at a rate faster than that of any transatlantic liner; that they are capable of a maintained sea speed for a long voyage up to the average rate of the express mail steamers, and that in the economical consumption of coal for power developed and speed produced they are the equals of any vessels afloat both in engine and boiler capacity. With these points thoroughly proven, it does not seem unreasonable to conclude that the one remaining feature—ability to stand hard driving through a heavy head sea—will also be found possible. While the criticisms on this point are made by men of undoubted ability and world-wide reputation, it will be noticed that they are not made in the form of positive assertions and predictions, but rather as a surmise, just as it was feared that the central screw would not have solid water in which to work. Still it is a point worthy of attention, and an actual trial would be worth more than all the surmises and opinions that could be expressed till the end of the next century.

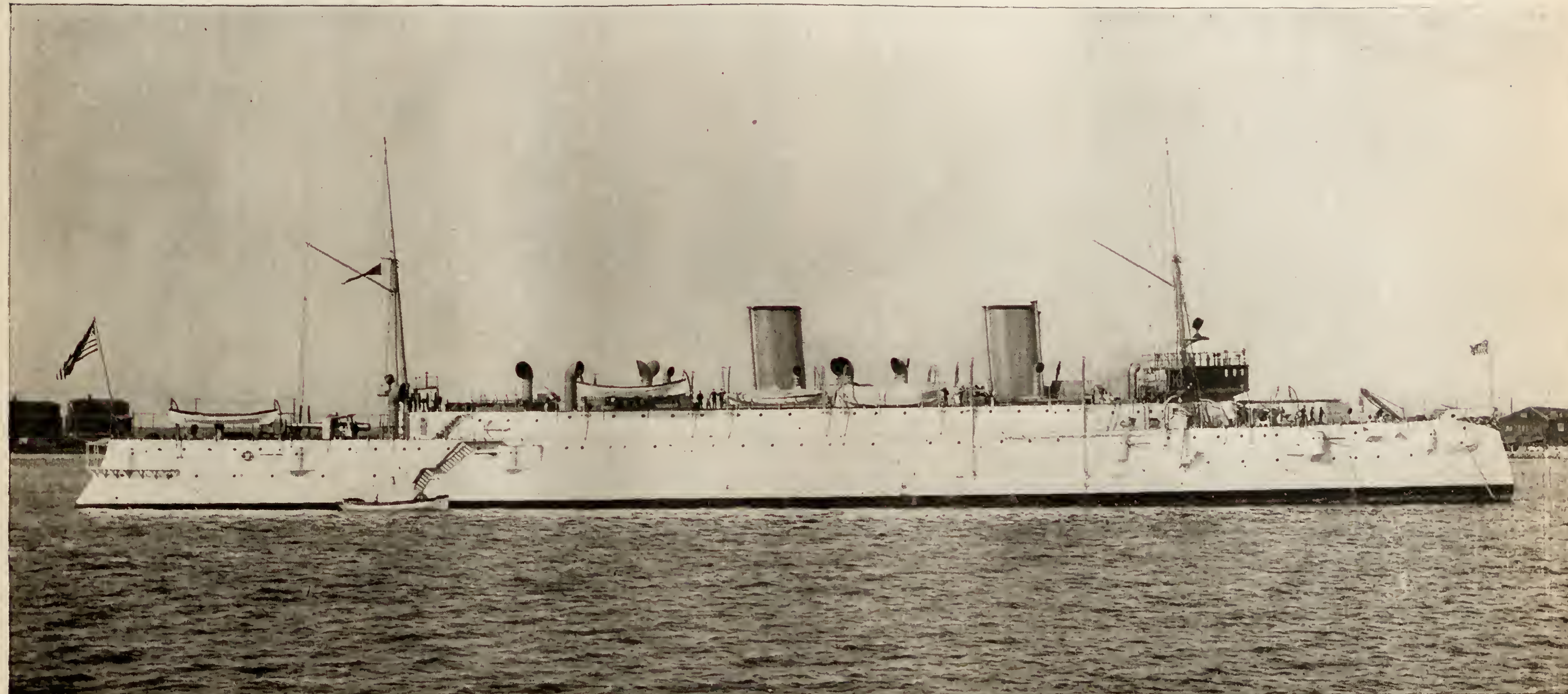


END ELEVATION OF COMPRESSED AIR AND WATER-PRESSURE ARRANGEMENTS OF FLUE-TESTING MACHINE AT WEST PHILADELPHIA.

ELECTRIC RAILWAYS IN MARYLAND.

The idea of utilizing electricity to supply means for local transportation has taken a strong hold upon the people of Maryland. In many parts of the State farmers, fruit-growers and quarrymen are remote from the railroads, and are practically without facilities for sending produce quickly to the market. Within a brief period these people have seen the city of Baltimore leap suddenly forward a quarter of a century through the agency of rapid transit. Before their astonished gaze the problem of connecting the business centre with the distant suburbs has been worked out, whereby the value of property is enhanced and the circle of possible residence for city people vastly widened. They have seen popular resorts spring up 10 miles from the city, inviting crowds daily to the enjoyment of cool breezes and delightful shade. Moreover, this spectacle has created a profound impression upon practical men in the counties, and they have begun to ask why electric railroads running along the turnpikes should not do for rural communities what they have done for the territory immediately surrounding Baltimore.

The evolution of electric railroads in Maryland exhibits three successive stages, two of which have been passed. After a few unsuccessful experiments with electricity as a motive



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THE UNITED STATES CRUISER "MINNEAPOLIS."

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THE UNITED STATES CRUISER "COLUMBIA."

power for street cars, its use was abandoned, and the first lines to introduce rapid transit employed the cable motor. But the expense of construction soon put an end to that, and the several street-car companies in Baltimore took up the trolley system and set about making the necessary changes to put it into use. Within three years all the old horse-car lines have been fitted out with the new appliances, requiring 275 miles of track to be replaced, and calling for an expenditure of $10,000,000 in the way of improvements. This constituted the first stage.

The second step was to expand these city systems by building roads into the suburbs. With a single exception, the corporations owning street railways in the city have extended their tracks greater or less distances into the adjoining counties. Lines are now in operation to Curtis Bay, across the Patapsco River; to Catonsville, 6 miles southwest of the city; to Powhatan and Gwynn Oak Park, forming an extension loop nearly 10 miles in the circuit; to Pikesville and Arlington, each 7 miles from Baltimore; to Lakeside Park; to Towson, the county-seat of Baltimore County; to Highlandtown and Point Breeze, 3 miles down the river; while a company has been formed to build a trolley line to Mt. Washington, 12 miles from the City Hall, and the road-bed is being graded for the new line to Ellicott City, which will be 11 miles in length. These suburban roads are legitimate extensions of the city systems, and are operated by the same companies. They have been built to satisfy the demands of local traffic, and the success of the experiment may be judged from the results achieved on the Pikesville branch of the Traction Company. This line starts near Druid Hill Park, in Northwest Baltimore, and follows the turnpike to Pimlico and thence by separate tracks to Pikesville and West Arlington, the road deriving its patronage largely from the people who go daily to the racing grounds at Pimlico and Arlington. The property is capitalized at $500,000, earning 6 per cent. on that amount, and it may be taken as a fair illustration of the income received on other suburban lines.

The third stage in the development of electric railroads in Maryland is yet in its beginning. Thousands of people annually attend the gatherings at Emory Grove and Glyndon, points about 20 miles from Baltimore. The Western Maryland Railroad passes in front of both camp grounds, and has been hitherto the chief source of communication between them and the city. But a company was formed last year, independent of the city railway corporations, to build a trolley road from Pikesville to Reisterstown, with a branch running up to Emory Grove. This line was opened to traffic in the month of May, the fare being 50 cents for the round trip, or $1\frac{4}{10}$ cents a mile. The road is practically an extension of the Pikesville branch of the Traction Company's system, except that it is owned and operated by a separate company, passengers being obliged to transfer from one line to the other on the platform in Pikesville. However, by a traffic arrangement between the two companies it is possible to purchase tickets from conductors on any of the Traction Company's lines in the city and ride to Emory Grove by making the necessary transfers. By this means is realized not only a cheaper form of transportation, but, in open cars, a more delightful mode of travel between Baltimore and the two most popular camp grounds in Maryland. It will be seen that the chief inspiration of building this railroad lies in the fact that a large volume of traffic was ready to make use of it as soon as completed.

Operations also have begun on what has been called the Baltimore-Washington Boulevard. This magnificent scheme has been reduced somewhat in dimensions until it consists of nothing more than the construction of a double-track electric railway between Baltimore and the national capital. Present indications point to the early completion of the road, possibly by installments, and the establishment of a line of communication in competition with the steam railways. A sufficient motive also exists for the construction of this line. People pass between Baltimore and Washington by the hundred thousand every year. Having a monopoly of the means of communication, the railroads have never reduced the regular fare below $2 for the round trip, and a trolley road between the two cities, passing through several of the growing towns along the way, would open up facilities for travel which would not only be popular, but exceedingly profitable on a basis of $1 for the round trip.

It is quite likely that the steam railways may inaugurate a rate war with the electric line when it is finished, but there will be small chance of the older companies driving the newer one out of the field so long as travel in trolley cars is made comfortable and exhilarating as it now is. To ride in warm weather in a swift-running coach, open to all the breezes of heaven and entirely free from the dust and cinders, would invite patronage even if a higher rate is charged than on the steam railroads. A proposition has been made also to extend the Pikesville & Reisterstown Railway to Westminster and Union Mills, and for the promotion of this scheme a company was organized last fall in Westminster. The managers met a serious difficulty on the threshold of the undertaking by the turnpike company demanding a half interest in the road as a concession for the right of way. But means will be found ultimately to bring the turnpike company to terms, or to take the road into Westminster along some other route, and it is quite likely that the enterprise will develop during the present year. Should this road be built, the way will then be opened to an extension of the line to Gettysburg, when a system of electric transit will have been inaugurated in Maryland which will settle forever certain questions regarding this new mode of transportation.

It will be seen, however, that in constructing the proposed electric railway beyond Reisterstown the chief object sought is not the same which has prompted the investment of capital in the other lines. To that point the management looks only to the carrying of a very large number of passengers to and from the camp grounds at Glyndon and Emory Grove, the connecting of Reisterstown with Baltimore being only incidental to that object, but at Reisterstown conditions change. A railway built to Westminster and Union Mills must depend as much upon carrying freight for revenue as upon carrying pas-

ELECTRIC RAILROADS OF MARYLAND.

sengers. One of these towns is already connected with Baltimore by rail, and passenger traffic alone is not sufficient to warrant the introduction of competition over an electric line, without resort also to the handling of freight. But Carroll County is a dairy region, large quantities of milk being transported at all seasons of the year to Baltimore. It is proposed, therefore, if the line is built, to run milk trains by electricity, and it is possible also that the lighter forms of truck would soon move over the electric road. This constitutes a new departure in the application of trolley roads to local traffic, and it represents the logical outcome of the third stage in the development of this form of transportation.

Examination of a good map will leave the impression that Maryland is pretty well supplied with steam railways, while an appeal to statistics will tend to strengthen that notion. According to the Inter-State Commerce Report for 1893, there were 1,299 miles of railroads within the State. This is 13 miles to each 100 square miles of territory, and about 12 miles to each 1,000 of the population. Comparing these figures with those of other States, there are only a few commonwealths which can boast of greater relative mileage. But the facts are misleading to a certain extent. With the exception of the Western Maryland system, the railroads running into Southern Maryland and a portion of those on the eastern shore, the steam railways of the State are trunk lines, paying small attention to local traffic. It is the winding of the Baltimore & Ohio Railway along the valley of the Potomac for nearly 500 miles, and the passing of the lines of the Pennsylvania system across the State from Washington to the Delaware line, that gives to Maryland its large percentages. The Baltimore & Ohio system skirts the extreme verge of several counties, and affords very poor facilities for local traffic. There is considerable territory in Maryland which has no railway communication at all, and the practical farmers, business men and manufacturers of the Terrapin State, are looking confidently to the building of electric railroads to supply the lack. Conditions are most favorable, therefore, not only for the extension of such lines outward from Baltimore, but for connecting the larger towns of the counties by trolley roads along the turnpikes. There is no hope for the complete accommodation of local traffic, except in multiplying steam railways or having recourse to the new, light-running electric cars.

ELECTRIC AND OTHER RAILROADS RUNNING OUT OF BALTIMORE, MD.

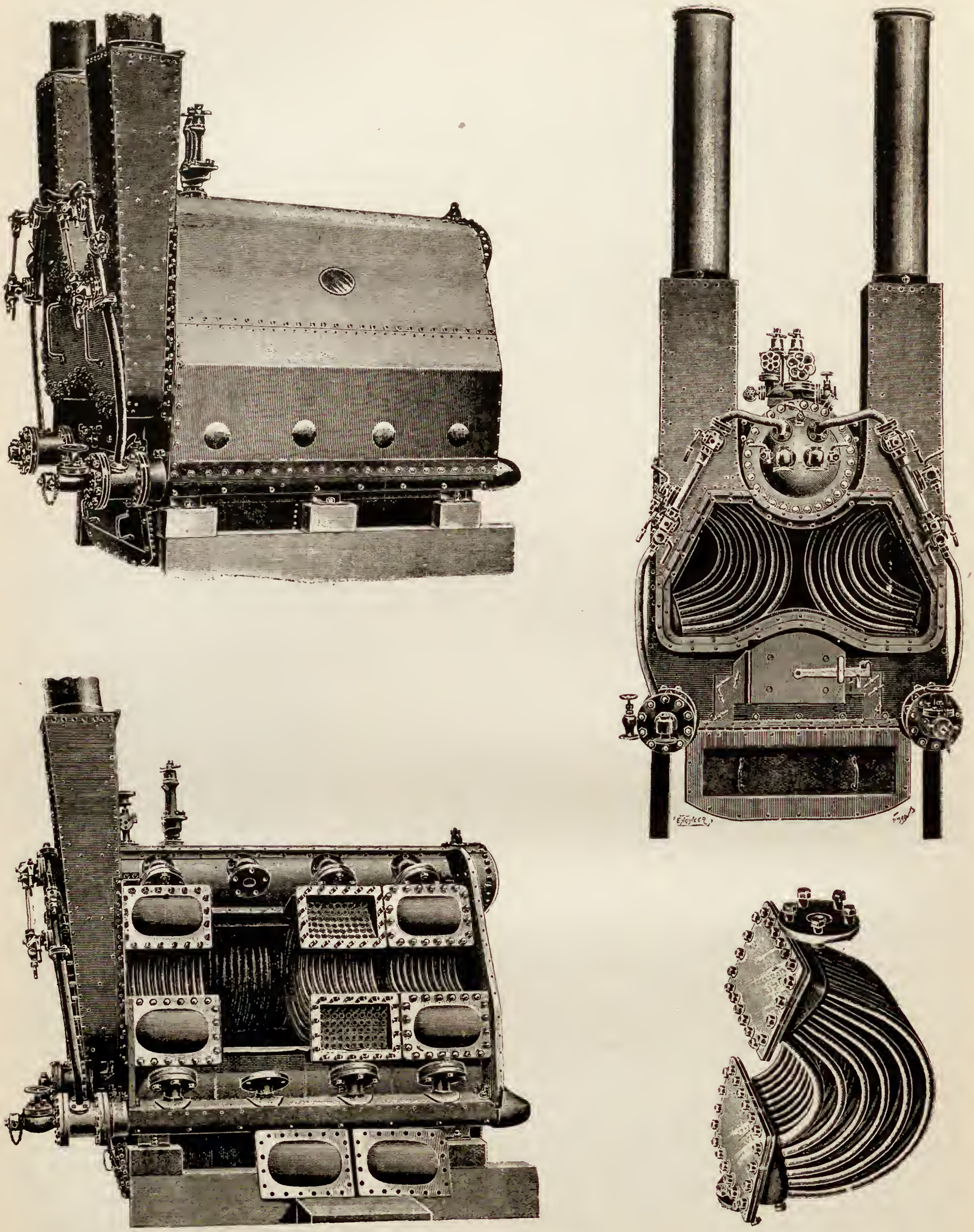
To show how far the matter has gone, it is necessary only to mention some of the projects which have been proposed for building trolley railroads in Maryland. Two years ago a company was formed and stock subscribed for an extensive electric rail-way system in Frederick and Washington counties, connecting Frederick with the principal towns of the Catoctin Valley, and running over into the populous and rich region known as the Middletown District, the whole system finding an outlet at Brunswick on the Baltimore & Ohio Railroad. This ambitious scheme would have accomplished the double purpose of enlarging the field of trade for Frederick City, and of opening one of the richest agricultural sections in Western Maryland to direct communication with better markets. But the undertaking fell through after ground had been broken for the line over Catoctin Mountain, and after a few thousand dollars had been spent in machinery. The panic of 1893 had fallen, and it was impossible to negotiate the securities.

A similar project has been advocated also on the eastern shore of Maryland, to unite the county seats and establish something like a rational system of communication among the towns of that part of the State. A company to promote and build this line is already in existence, though nothing actually has been done toward placing the stock or making capital available for the construction of the lines. The steam railway facilities of the eastern shore are so placed as to interfere with rather than to encourage communication between the Maryland towns and to unite their interests with Baltimore. The main line runs through Delaware, sending out short branches to the several Maryland county seats. These extend far northward ; and to go by rail from Cambridge to Easton, for example, requires one to traverse the greater part of the State of Delaware, while the two cities are only 25 miles apart. The truth is, the railways of this region were built chiefly with a view to running produce into Philadelphia, and the freight accommodations on the eastern shore have not only been a cause of complaint for years, but they inspired the building of the Baltimore & Eastern Shore Railway, and have given an immense impulse to the multiplication of facilities for water communication with Baltimore.

These are two of the most ambitious schemes for building electric railroads outside of the city, though by no means all that have been projected ; and they serve to show the need of better local transportation facilities in Maryland, as well as an eagerness among the people to obtain them. If the commonwealth is to grow and to acquire the population which its agricultural territory is capable of supporting, people in the rural districts believe that something besides wagon roads are necessary between the principal railroad stations and the places of production in the counties.

What is true of Maryland in this respect is measurably true of other States. Steam railroads serve a most useful purpose, but they do not in all cases provide the best facilities for local traffic. Indeed, there are expanses of territory in almost every county in the United States as remote from market as though railroads and improved waterways did not exist. To such localities the light-running electric car on its cheaply constructed roadbed promises relief, and in this particular the long-distance trolley seems destined to become a mighty agency of progress in the United States.

Smokeless Powder.—A number of the largest firms of powder manufacturers are now working hard to produce a satisfactory smokeless powder. None which has yet been made has been satisfactory for the large seacoast guns for which it is most desired.



THE MUMFORD WATER-TUBE BOILER.

THE MUMFORD WATER-TUBE BOILER.

Among the various water-tube boilers now in the market, that which we illustrate on page 416 is not the least successful. Like all boilers of the kind, it has been evolved by a series of experiments carried on for many months. The great object sought to be obtained was the production of a boiler which admitted of a prompt and easy repair, while it should not be less economical and efficient than other water-tube boilers. Its principle of construction is so simple that it will be understood from the drawings, almost without a word of description, by any one who is conversant with water-tube express boilers. There are now 11 of them supplying steam to a similar number of engines in the pinnaces of the British Navy ; and they have, we understand, up to the present given great satisfaction. They are all worked in close stokeholds with forced draft. It may be added that while two chimneys are shown in our illustrations, one can be used if preferred ; but we believe that the Admiralty authorities prefer two.

From the illustrations it will be seen that the boiler is constructed in elements, or groups of tubes, fitted into top and bottom boxes, which are of forged steel, having one inlet in the bottom box and one outlet in the top box. Without lifting the boiler any of these elements or nests of tubes can be disconnected and lowered into the furnace space and removed through the furnace front for repairs without disturbing the remainder of the boiler or necessitating the breaking of any joints beyond the two connected with the element to be removed. By removing the top and bottom covers of the tube boxes a single defective tube in any position can be removed and replaced by a new one without interfering with the surrounding tubes. The boiler can be constructed either with direct through or return draft, and the smoke-box placed at either end, according to the position of the baffle plates among the tubes. There is at the back end a ⊥ down-cast pipe for returning water to the lower feeding tubes.

It might be imagined that the bolted joints would give trouble and cause some delay in putting the parts together. As a matter of fact, by an extremely simple expedient the joints are made perfectly tight without asbestos, cardboard, wire gauze, tape, lead, or cement of any kind, and the faces are not scraped up. The joint can be made and unmade as often as needed without any trouble. A noteworthy feature is the small comparative size of the tubes which supply the lower boxes with water, and deliver steam and water into the steam drum. It might be thought that congestion would take place in the small boiling tubes, and that they would become dry and would burn. But, as a matter of fact, nothing of the kind has occurred. As much as 150 lbs. of coal has been burned per hour per square foot of grate, and 221 lbs. of water per hour have been converted into steam per foot of grate. Then the fire was drawn as quickly as possible, and the boiler cooled down without the least sign of leakage. It is difficult to believe that this quantity of coal could have been burned, but we are assured that there was a very small ejection of cinders. Of course this experiment was carried out with a fierce draft and no idea of attaining economy. In practice, about half the weight of coal is burned, and the economical efficiency is then very good, particularly in the larger boilers. The tubes are of galvanized steel, bent by the makers and rolled into the tube plates. The boiler is a little heavier per square foot of heating surface than some of the other express boilers, but it is lighter than the locomotive type of torpedo boiler. All the details of construction, on which so much depend, have been very carefully worked out. We may add that the boiler is placed at some disadvantage by want of height in the smaller sizes. In larger vessels, such as torpedo catchers and yachts, where plenty of height is available, the economical efficiency of the boiler is greatly increased, and, compared with the power, its weight diminished. In that case a longer boiling tube is used, and the curves are differently arranged. —*The Engineer*.

H.M.S. "POWERFUL."

The first-class protected cruiser *Powerful*, which was launched at Barrow on July 24, is a sister ship to the *Terrible*, launched from the Clydebank Shipyard on May 28. Both vessels have been built to the same drawings so far as constructional work is concerned, and putting aside the design of the engines and general arrangement of machinery. These vessels are the largest cruisers ever constructed. They have been designed by Sir William White, the Director of Naval Construction. They are each 500 ft. long between perpendiculars, or 538 ft. over all. The width is 71 ft., and the designed draft 27 ft. The displacement at that draft will be 14,200 tons. This is only 700 tons less than our largest battleships of the *Magnificent* class, and about 200 tons less than the Italian vessels of the *Italia* class, for so long the largest war-vessels in the world, which are described as "armored" ships, though they have no armor in the shape of belt or for side protection. The *Powerful* and *Terrible* have a considerable proportion of their displacement devoted to armor, there being the armored deck, with a *maximum* thickness of 4 in., the conning-tower, the barbettes, and the casemates of 6 in. thickness, besides ammunition trunks and additional protective plating at the backs of the casemates and elsewhere. If the tendency toward suppression of side armor in battleships, which was so apparent a few years ago, and of which the *Italia* may be taken as an extreme example, had continued, it would soon have been difficult to draw the line between battleships and cruisers in view of the reduction in calibre of principal armaments. The *Italia* has four 100-ton guns. This alone is sufficient to differentiate her from the *Powerful*, which has no larger weapon than the two 9.2 in. guns mounted fore and aft. The *Italia* is credited with 18 knots on her trial, while the *Lepanto*, a more recent vessel of the same navy, steamed about a third of a knot faster. It is, however, hardly worth while to compare these two vessels, which have fifteen years between the dates of launching, and which have been designed for such different duties, although, in view of the approximation in size and the disposition of armor, the opportunity is somewhat tempting.

In an inspection of the *Powerful* as she stands in the yard of the builders, the Naval Armaments & Construction Company, the first thing that strikes one is the unusual precautions taken to insure safety in launching, a matter which has been enforced upon the attention of shipbuilders by recent events. The launching weight will be about 7,300 tons, and in order to take this the ways have been made no less than 5 ft. wide. The heavy timbers, or "poppets," which form the cradle on which the vessel rests as she is launched are all vertical, in place of their being inclined. On the forward cradle there is a steel plate which is bent to the shape of the vessel, or to a V section. This passes under the bottom, the top edges on each side being riveted to a shelf, which hooks on to the heads of the poppets. The structure is further strengthened by a number of turns of heavy chain, which are attached to the cradle on each side and pass down under the keel of the ship, thus strengthening and supporting the plate. In a long and heavy vessel such as this the necessity for precautions of this nature has been much emphasized of late. When the after part of the vessel is water borne a great strain is thrown on the forward part of the cradle, which might possibly, under certain conditions, give way. Inside the vessel equal precautions have been taken to provide against straining the hull structure itself, the double bottom space being extensively timbered, and the decks strutted throughout with heavy timber balks.

The armament of the *Powerful* will consist of two 9.2-in. guns, twelve 6-in. quick-firing guns, sixteen 12-pdr. quick-firing guns, and twelve 3-pdr. quick-firing guns, with nine machine guns and two lighter guns. The barbette armor for the protection of the bases of the mountings of the two 9.2-in. guns is in place. These weapons are mounted on the upper deck forward and aft, and have, therefore, an extended arc of fire. The armor for the barbettes and conning tower has been supplied by Messrs. John Brown & Co., of Sheffield. It is of Harveyized steel. The rings of armor are composed of four segments, which together form a dwarf roll or cylinder 15 ft. 6 in. diameter and 2 ft. 6 in. deep. The shield for the protection of the gun will, of course, be raised above this fixed armor. The armor plates which form the outside part of the casemates for 6-in. quick-firing guns are very fine pieces of work by Messrs. Cammell, of Sheffield. The twelve 6-in. guns form the chief fighting element of the ship. Eight of these guns are placed on the main deck, four on each side. The two pairs forward and aft are arranged to have a wide range ahead and astern respectively. In order to provide for this the sides of the ship have been recessed so that the forward guns may be pointed well ahead and the aft guns well astern. The armor for these casemates is in two parts, the division being vertical in plane with the axis of the gun. Each of the two plates is about 13 ft. long and 7 ft. to 8 ft. high, the height varying with the position in the ship. As this is 6 in. steel armor, and as the plates have to follow the contour of the ship, which forms a considerable curve at the ends, it will be seen that powerful machinery is required to form these plates ; and here it may be said that the modern disposition of steel armor has only been made possible by the improvements of late made in hydraulic presses and special machine tools. The plates are, however, not only bent to a

considerable curve, but the part which would formerly have been cut out to form the gun port has not been entirely removed, but has been bent inward, thus forming very efficient protection to the guns' crews. The design is not altogether new, it having been adopted in some previous cruisers designed by Sir William White, but it is worthy of notice as an example of the difficult work which the steelworker of to-day can perform by means of powerful modern machinery. The broadside casemates, of which there are four in all, form shallow sponsons standing out from the ship's side, thus increasing the range of fire, which amounts to 60°. The four remaining 6-in. guns are mounted in casemates placed immediately above the fore and aft casemates on the main deck. All these casemates have 2-in. armor at the back to protect the crews from splinters of shell or *débris*. The ammunition is brought up through armored trunks, the trunk for the upper deck guns being brought up through the back of the main deck casemates. Dismounting rails are fixed to the deck, and by the aid of these the guns can be slung and traversed back so that they may be housed well inboard outside the casemates.

Turning to the more general features of hull structure, we find that great pains have been taken by skilful disposition of material to get extreme lightness combined with the great strength and rigidity required in a vessel of this nature. The armored deck is, of course, a great feature of strength, and affords an excellent foundation to work from. Under the machinery space there is the usual double bottom, which extends from edge to edge of the armored deck. Above this the ordinary frames are spaced 2 ft., but every sixth frame is a deep web frame stiffened by a reverse angle. These frames are 2 ft. 6 in. deep, and are 12 ft. apart. This form of structure extends from the armored deck to the upper deck.

The armored deck itself is composed principally of three thicknesses of steel plating, but at the edges, where it joins the side of the ship, two of the skins of plating are discontinued, so that the extreme edges of the deck, for a width of a foot or two, are only one skin of plating. This feature, which, presumably, is chiefly to facilitate and cheapen construction and save weight, has been very severely criticised in some quarters; but the objections raised are more apparent than real. With the ship at rest the edges of the deck are a long way below water-level, and it is only when the vessel is rolling that the supposed defects would be manifested. To bring the lower edge of the deck to the surface, however, would require a considerable roll. If the ship were rolling from the enemy the tendency would be to bring the edge of the deck more nearly parallel with the line of fire, when penetration would be far more difficult. If the ship were rolling toward the enemy the high crown of the very much arched deck would have to be surmounted. In these considerations the trajectory of the shot is supposed to be flat; with a plunging fire the danger would be increased, but that applies to deck protection generally. A cruiser, not being designed for the line of battle, must take its chance. There is, however, another argument to be advanced in favor of the thin edges—namely, that a shot penetrating them would not pass into any of the large compartments of the ship, but into the double bottom space, unless, of course, it pierced both the inner and outer skin. Whether the thinner edges for the armored deck are or are not a desirable arrangement may be a matter of opinion, but the points now advanced are worthy of attention in view of the fact that only adverse criticisms have been hitherto heard.

The machinery space occupies about half the length of the ship—240 ft.—and this, of course, in the middle part of the vessel. Such is the price paid for high speed. The coal capacity of these vessels is very large, the *maximum* amount carried being 3,000 tons. A good deal of this coal is utilized as protection against the destructive effects of shell fire. At the time of launching the ship will be far nearer completion than is often the case with vessels of this kind. All the armor proper is in place, pedestals for gun mountings, skylight and companion ways, etc.; even a great part of the joinery work is fitted. In regard to the latter great pains have been taken

A HOME-MADE YARD CRANE, CENTRAL VERMONT RAILROAD.

to reduce the quantity of wood used as much as possible. The necessity for this has been amply proved during the recent war in the East between China and Japan. To the credit of the Admiralty it may be said, however, that this was previously recognized, and Sir William White had made provision for reducing the risk of fire during action before the late war began. In the *Powerful* steel panels are largely used in place of wood for cabin partitions, etc., and sheet-steel is largely used in all places possible.

The ship has been constructed under the inspection of Messrs. Millard & Dally, of the Controller's Department at the Admiralty, Mr. Adamson being managing director for the contractors. M. A. B. Gowan has had charge of the shipbuilding department as works manager.

The engines of the *Powerful*, which consist of two pairs of three-stage compound engines, designed by Mr. A. Blechynden, have cylinders 45 in. high-pressure, 70 in. intermediate, and two low-pressure cylinders each of 76 in., the stroke 48 in. These incorporate the modern features of steel in place of iron and large bearing surfaces. The boilers are, as in the *Terrible*, of the Belleville type. As in the *Terrible*, there are 48 in all, in eight water-tight compartments. A more extended description of the machinery may be left until its performance is proved by the trial trip of the vessel. It may be stated, however, that there are 144 steam cylinders in the main and auxiliary engines, the former, however, contributing but eight of these. The boiler pressure will be 260 lbs. to the square inch, with reducing valves to bring it down to 210 lbs. in the cylinders. The total I.H.P. will be 25,000 at 110 revolutions. The legend speed is 22 knots.—*London Times.*

YARD CRANE, CENTRAL VERMONT RAILROAD.

In our last issue we illustrated a home-made wrecking crane that is in service on the Central Vermont Railroad, and which is doing satisfactory service. In the St. Albans yard there is a crane made at the shops there that may serve as a hint to those who must have a crane and who are compelled to build for themselves. The illustration on the opposite page gives a very clear idea of the construction. Like the wrecking crane, it turns upon a central post that is firmly attached to the framing of the car, but while the thrust of the former is taken up at the foot of the boom, the weight supported by this one is counterbalanced by the weight in the box at the back of the cranks. In order that a balance may be secured under all variations of load, the boom and the counterweight-box can be racked back and forth on the framing that is fastened to the central post, and the leverage of the weight thus varied to suit the circumstances of the case in hand. The crane is mounted upon a four-wheeled car with the pedestals attached directly to the side-sills, as shown. A brake consisting of a stick pivoted at one end, and having a bearing on the driven gear of the drum, serves to hold the load and to lower the same. The car is so light that it can easily be pushed from one point to another without a locomotive, and is used for handling heavy weights between the trucks and the cars.

NEW COMPOUND LOCOMOTIVES FOR THE ST. GOTHARD RAILROAD.*

By Edward Sauvage.

The St. Gothard Line, between Lucerne and Chiasso, is composed of sections where the grades do not exceed 1 per cent., and of others where the inclination is 2.6 and even 2.68 per cent. From Lucerne to Erstfeld we have a level stretch of 41.3 miles where the grades do not exceed 1 per cent., and which consists of the section from Lucerne to Immensee, which does not belong to the St. Gothard Railroad, and the section from Immensee to Erstfeld. The St. Gothard Company is about to build a new line from Lucerne to Arth-Goldan (5½ miles beyond Immensee), which will run close to Lake Geneva, and will be shorter than the present line. From Erstfeld to Goeschenen the road rises, in a distance of 18 miles, from an altitude of 1,560 ft. to 3,632 ft., giving an average gradient of 2.19 per cent., while the actual grades are as much as 2.6 per cent. Between Goeschenen and Airolo (a distance of 9.32 miles, of which 8 7 miles is in the great tunnel) there is a grade of .58 per cent. for a considerable distance, followed by inclinations of from .05 to .2 per cent. From Airolo to Biasca, a distance of 28.33 miles, the road descends from an altitude of 3,756 ft. to one of 971 ft., over an average grade of 1.86 per cent., but which in some places is as much as 2.68 per cent.

* From the *Revue Générale des Chemins de fer.*

From Biasca to Bellinzona the steepest grades are only .08 per cent. In like manner the branch lines running from Bellinzona to Locarno and Luni are practically level.

The line from Bellinzona to Chiasso is undulating; it rises to an altitude of 1,560 ft. to drop again to 787 ft. Between Bellinzona and Lugano the gradients rise to as much as 2.6 per cent. in one direction and 2.1 per cent. in the other; they are 1.67 per cent. between Lugano and Chiasso.

The average speed between two stations on the heavy grades is actually from 18.6 to 21.1 miles per hour for the fastest express trains; two locomotives are used, and sometimes three (two at the head and one at the rear of the train) when the weight of the express trains exceeds 90 gross tons. The engines are changed at Erstfeld and at Biasca, at the foot of the heavy grades.

The management of the St. Gothard Railroad desires to make certain of hauling express trains by locomotives powerful enough to increase the average speed, and at the same time make double-heading less frequent, and fast enough upon the level lines to avoid the necessity of relays at the foot of the heavy grades. Two compound engines have been built for this purpose and are now on trial.

These two engines have boilers of identically the same dimensions; they are very large and intended for a pressure of 196.5 lbs. per square inch; they are carried upon three coupled axles and a bogie. One of them has four cylinders, two high pressure on the inside, having a diameter of 13.8 in. with a stroke of 23.6 in., and the two outside low-pressure cylinders have a diameter of 20.9 in., with a stroke of 23.6 in. The other engine has three cylinders, one being a central high-pressure cylinder of 17.3 in. diameter, and two low-pressure cylinders that are smaller than those on the other engine; their diameter is 18.9 in. The stroke of all of the pistons is 23.6 in.

The diameter of the driving-wheels is 5 ft. 3 in. The connecting-rods of the low-pressure outside cylinders are connected to crank-pins on the second drivers; the first axle is, on the other hand, a crank axle, and is driven by the connecting-rod or rods of the high-pressure cylinders.

A special apparatus permits direct steam to be admitted to and the exhaust to be led from all of the cylinders.

Fig. 1 is a longitudinal section, fig. 2 the plan, and figs. 3 and 4 cross sections of the three-cylinder machine, while fig. 5 is a side elevation of the two engines. The principal dimensions of these locomotives are as follows:

Heating surface of fire-box		132.4 sq. ft.
" " " tubes (inside)		1,485.4 sq. ft.
Total		1,617 8 sq. ft.
Number of tubes		244
Internal diameter of tubes		1.77 in.
External " " "		.2 in.
Length of tubes		13 ft. 1½ in.
Grate area		24.75 sq. ft.
Steam pressure		196.5 lbs. per sq. in.
Diameter of driving-wheels		5 ft 3 in.
" " truck "		2 ft. 9½ in.
Rigid wheel base		11 ft. 6.6 in.
Total " " of engine		28 ft. 6.1 in.
Diameters of cylinders:		
Four-cylinder engines	2 high pressure	13.8 in.
	2 low "	20.9 in.
Three " "	1 high "	17.3 in.
	2 low "	18 9 in.
Stroke of all pistons		23.6 in.
Weight, empty		About 59 gross tons
" in working order		" 65 " "
" on drivers		" 45 " "

TENDER.

Diameter of wheels	3 ft. 4.2 in.
Total wheel base	10 ft. 6 in.
Coal capacity	5 gross tons.
Capacity of tank	3,960 galls.
Weight, empty	About 13 gross tons
" loaded	" 33 " "
Total length of engine and tender	50 ft. 2¾ in.
" wheel base of engine and tender	40 ft. 8 in.
Total weight of engine and tender:	
Empty	About 72 gross tons
In working order	" 98 " "

The valves are of the Allen type, are made of cast iron placed over the cylinders, and are operated by the Walschaert gear, with balancing strips on the top.

The engines are equipped with the Westinghouse-Henry automatic and adjustable brake.

Among the details of construction we would call attention to the following:

The tires are rolled with an external lip and are fastened by

FIG 1

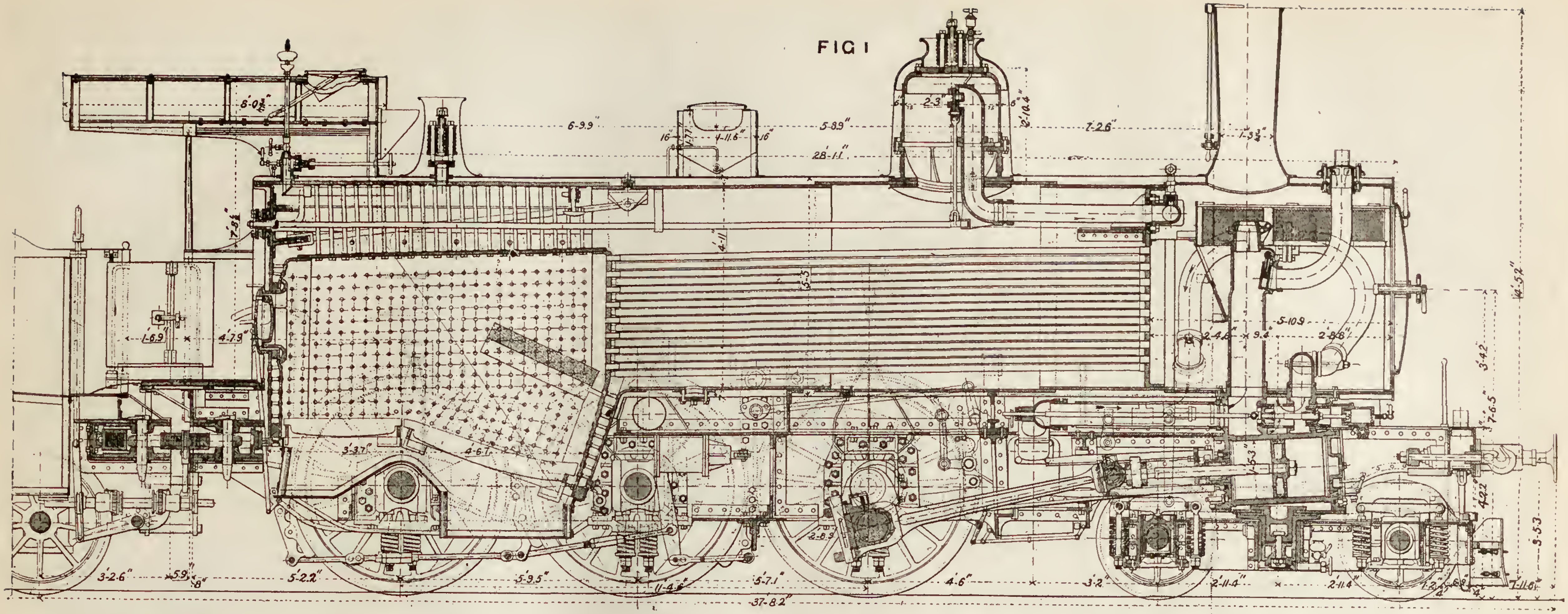
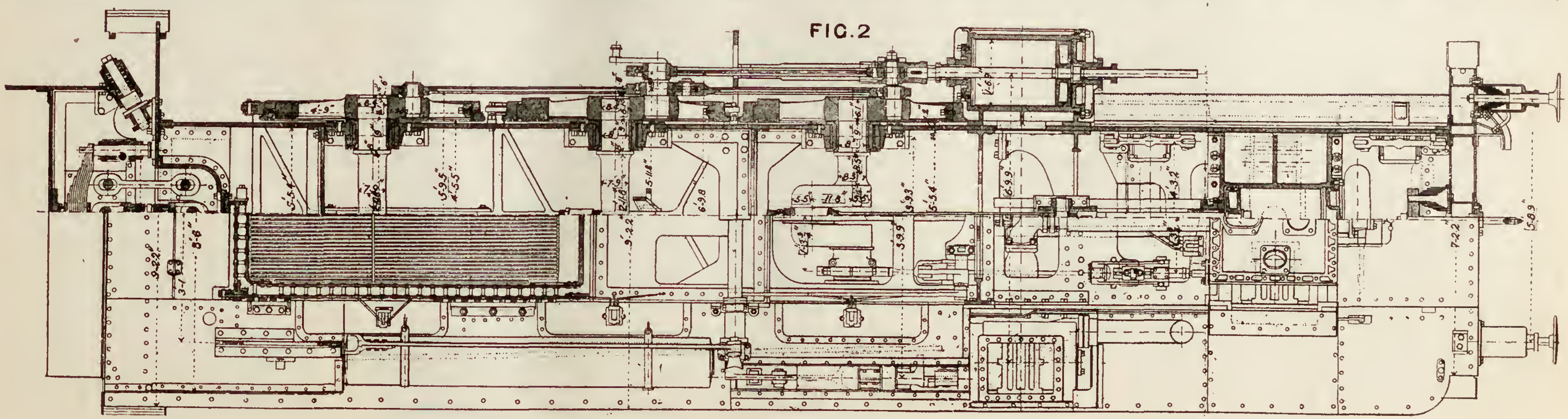
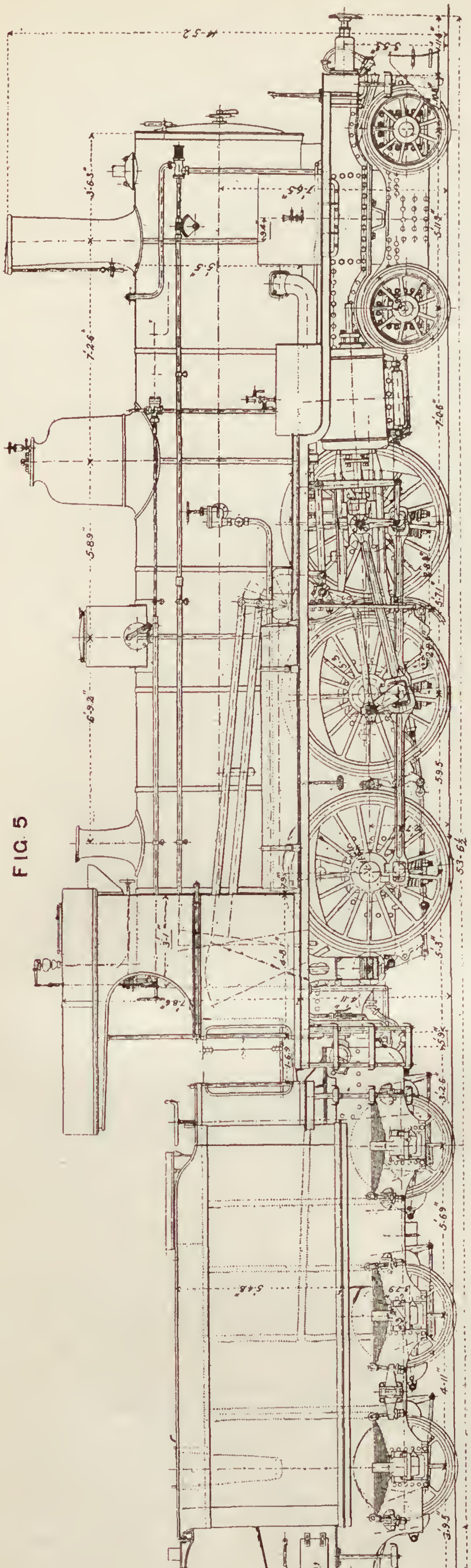


FIG. 2



THREE-CYLINDER COMPOUND LOCOMOTIVE FOR THE ST. GOTHARD RAILWAY.

FIG. 5



TEN-WHEELED COMPOUND LOCOMOTIVE FOR THE ST. GOTHARD RAILROAD.

turning it down upon an iron ring made in several pieces, according to the standard system adopted in Switzerland. The engine is hung upon coiled springs applied to the driving axles and to those on the bogie. The arrangement for the former is very simple, the springs being placed under the boxes; it is less so for the bogies. The engines ride very easy. In the tests to which they were subjected these carrying springs

FIG. 3.

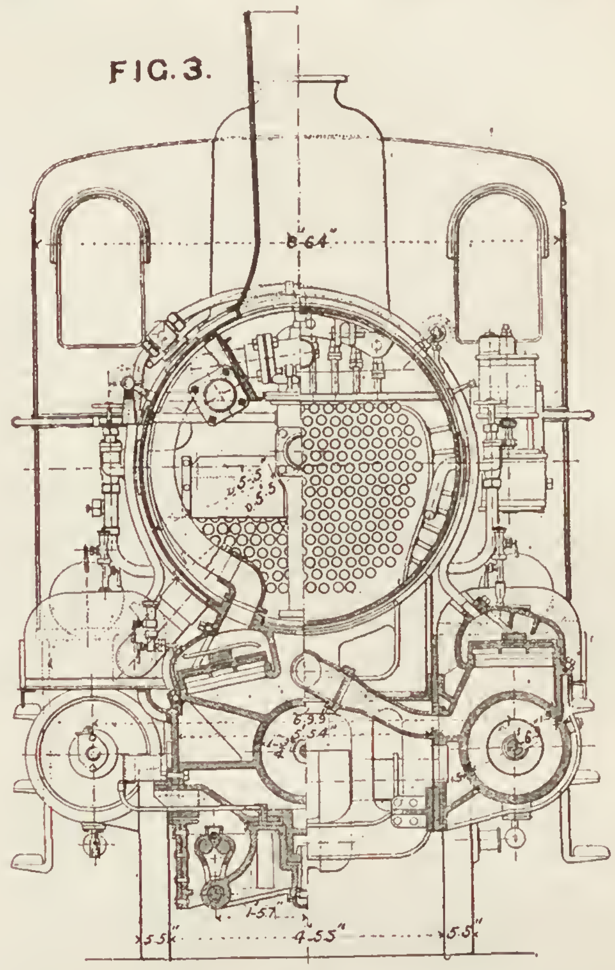
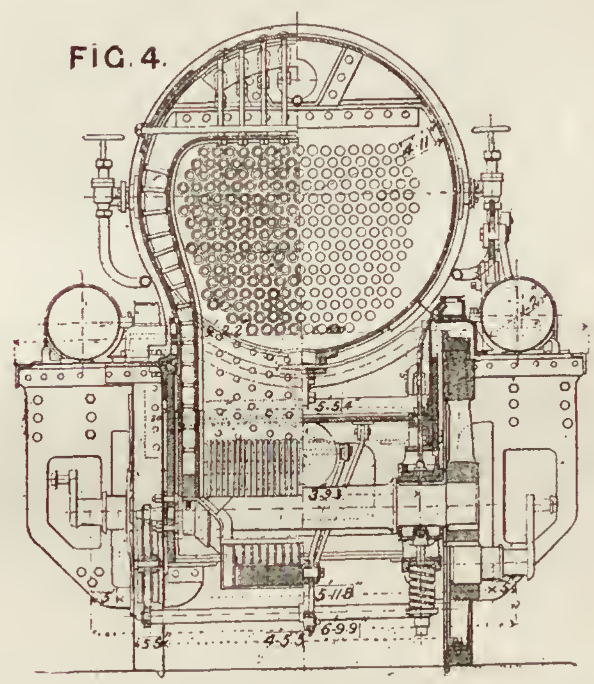


FIG. 4.



CROSS-SECTIONS OF COMPOUND LOCOMOTIVE FOR ST. GOTHARD RAILROAD.

showed that under a load of 2,000 lbs. the double-driver springs gave a deflection of .43 in.; under 4,000 lbs., .82 in.; under 6,000 lbs., 1.25 in.; and under 8,000 lbs., 1.57 in. The single bogie springs under a load of 2,000 lbs. deflected .79 in.; under 4,000 lbs., 1.42 in.; and under 5,000 lbs., 1.68 in.

The bogie has a lateral swing controlled by hangers. The bogie wheels pass beneath the frames of the engines. The bogie frame carries large fenders of sheet metal that are nearly vertical, and which stand at an angle with the rail so as to throw all obstructions to the outside. This is the regular arrangements on the St. Gothard locomotives.

The boiler has a large diameter (4 ft. 11 in. for the inside of the smallest ring). As the fire-box cannot be introduced through the bottom opening, the back sheet of this box is so flanged that it can be easily riveted from the outside after the box has been put in position. There are four direct-loaded safety valves, having a diameter of 2¾ in. The smoke-box is long. An ash-pan is placed behind the grate openings which

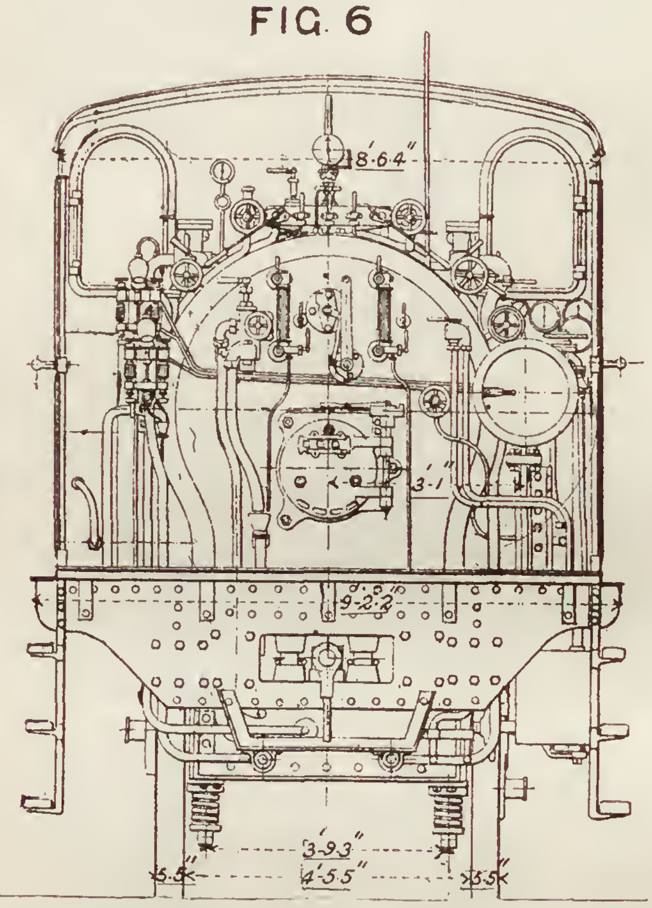
catches the ashes as they fall. The boiler is fed by three injectors ; and it is often found to be necessary to use two at the same time, the third being held in reserve. There are two water glasses, with a mark showing the lowest level for water on an up grade of 2.7 per cent.

In order to insure sufficient adhesion, the engines are fitted with an apparatus for washing the rails throwing a stream of water between the wheels of the bogie, and a pneumatic sander for the drivers. The exhaust pipe can be closed by a clapet valve operated by hand, which opens at the same time a pipe for the admission of air. The reversing mechanism for the two sets of high and low-pressure cylinders is operated by two reversing screws connected by gearing, so that the two can be operated at the same time by a single hand-wheel, while they may be disconnected when it is so desired, to be worked separately.

The starting mechanism is such that steam may be exhausted direct from the high-pressure cylinder or cylinders into the atmosphere without sending it into the receiver. At the same time steam may be admitted into this receiver directly from the boiler by means of a special throttle of small dimensions. The apparatus consists of pistons which work upon a cock in such a way as to realize the four following combinations :

1. Normal compound action.
2. Running with the high-pressure cylinders alone, exhausting directly into the atmosphere.
3. Running with the low-pressure cylinders alone, by opening the small supplementary throttle. The apparatus remains in the same position as for the second combination, and the main throttle is kept shut.
4. Running with direct admission into all the cylinders, the main throttle alone being open.

FIG. 6



REAR ELEVATION OF COMPOUND LOCOMOTIVE FOR ST. GOTHARD RAILROAD.

The lubrication of the valves and pistons is accomplished by two condensing lubricators with sight feeds and placed in the cab.

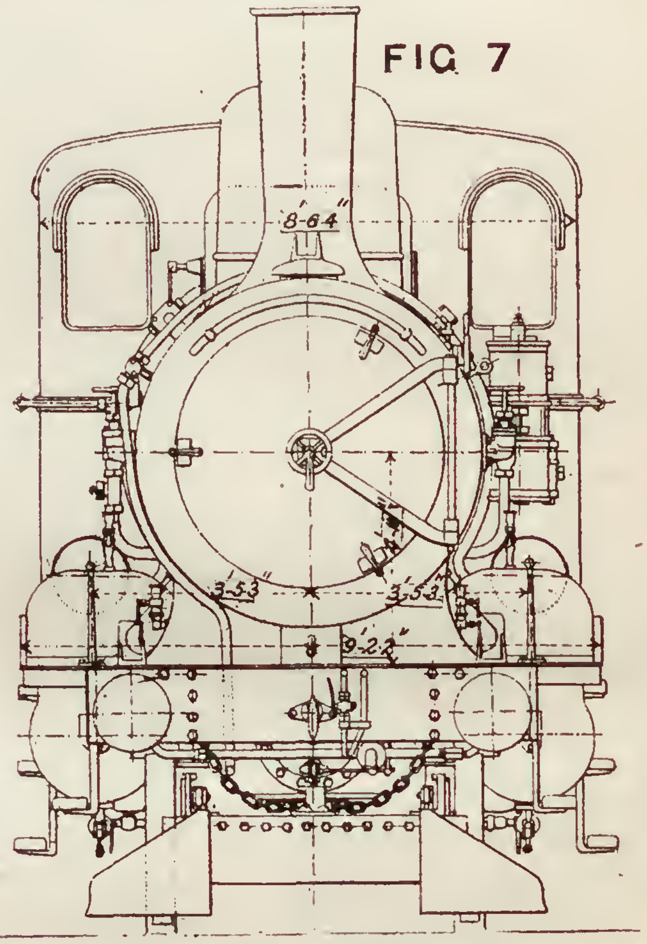
A special train weighing 120 gross tons was hauled from Erstfeld to Goeschenen by the four-cylinder engine. With the engine and tender the total weight was 215 gross tons. The running speeds were taken by means of a Klose apparatus. The 18 miles were run in 44 minutes, giving an average speed of 24.54 miles per hour. Between Erstfeld and Amsteg, where the heavy grades are not continuous, the speed rose to from 31 to 40 miles per hour ; from Amsteg to Gurtnellen it averaged about 20 miles ; it rose to 31 miles while crossing the yard of the Gurtnellen station ; a little further on there was some slipping ; the speed is maintained at about 22.37 miles on up grades of 2.5 and 2.6 per cent. ; it rose above 37.3 miles at the Wassen station, to drop back to from 23.6 to 24.8 miles on grades of from 2.2 to 2.5 per cent. A short distance beyond Wassen, in the spiral tunnel of Leggistein, the engine slipped several times, the grade being one of 2.2 per cent.

For the run from Goeschenen to Airolo, a distance of 9.75 miles, with a grade of .6 per cent., the weight of the train was reduced to 100 gross tons in order to secure a high speed. The run was made in 13.5 minutes, which gives an average speed of 43.5 miles per hour, without making any allowance for working up to speed and stopping. In the opposite direction the run was made in 12.5 minutes, the average speed being 46.6 miles per hour. The running speeds actually obtained were about 47.25 miles in going, and from 50 to 56 miles returning. The engine, although the diameter of the drivers is only 5 ft. 3 in., worked well at these speeds ; it sustained, to be sure, some violent oscillations at times, but these were due to defects in the track. The section from Goeschenen to Airolo is almost entirely in tunnel, and the maintenance of the track is consequently very difficult.

Finally the sheet of the Klose indicator shows the evenness of the descent from Goeschenen to Erstfeld. For this run the engine was doubled on a passenger train hauled by the other compound ; with the indicator and the adjustable brake the speed was held very uniformly at 28 miles, the engineers being allowed to run at the rate of 29 miles per hour. At some of the stations the speed was slightly increased because the brake was released when a considerable portion of the train was still on the grade. The effective pressure on the adjustable brake was about 14 lbs. per square inch. On reaching Erstfeld the tires were found to be so warm that the hand could not be held against them.

From the verbal reports that have been given me, the consumption of fuel and water for the rise from Erstfeld to Goeschenen, at the speed given, and with a train weight of 120 gross tons, was but a little more than 2,200 lbs. of briquettes and 2,110 galls. of water.

FIG. 7



FRONT ELEVATION OF COMPOUND LOCOMOTIVE FOR ST. GOTHARD RAILROAD.

The experiments with these engines were not prolonged sufficiently to get perfectly definite results. The engineers on the St. Gothard Railroad seem to prefer the four-cylinder locomotive, perhaps on account of the larger diameter of the low-pressure cylinders, which gives it more power and a better utilization of its steam.

From what I have seen, the steaming qualities of the boiler seem to be ample. As a vehicle, the engine passes easily around the curves and seems to be stable and steady ; the combination of three-coupled axles brought near together with a bogie truck is a good principle. These compound engines appear to satisfy the conditions demanded, to wit : great power for climbing grades combined with a facility for running at high speeds over the easy portions of the line.

Since the above was written new experiments have been made by the St. Gothard engineers, resulting in some modifications in the engines. The three-cylinder locomotive, which was found to be too weak, has been adjusted to run continuously with a direct steam admission into the three cylinders, while the four-cylinder locomotive, which appears to have given better results in service, is worked exclusively as a compound.

M. Dubois, Engineer for the Western Railway of France, who has recently visited the St. Gothard Railroad, has handed me the following report :

Conditions imposed upon building.

To haul 120 gross tons at a speed of 25 miles per hour on 2.5 and 2.7 per cent. grades.

To haul 200 gross tons at a speed of 37 miles per hour on 1 per cent. grades.

To haul 200 gross tons at a speed of 56 miles per hour on the level and up grades of .5 per cent.

AVERAGE OF RESULTS OBTAINED IN 12 TESTS BETWEEN ERSTFELD AND GOESCHENEN.

Engine.	Load.	Time of Run in Minutes.	Distance.	Consumption	
				Water.	Coal.
4 Cylinder..	120 gr. tons	43.3	18 miles	16,082 lbs.	2,662 lbs.
3 " ..	119 " "	44.2	18 "	19,162 "	2,965 "

In tests with the four-cylinder engine the consumption was lowered to 2,350 lbs. of coal and 15,620 lbs. of water.

With this same engine they have been able to go up a grade of 2.6 per cent. with a load of 120 gross tons at a speed of 34.2 miles per hour. The cut off was at 60 per cent. of the stroke in the low pressure and 55 per cent. of the same in the high-pressure cylinders.

With a cut off at 70 per cent. of the stroke in the low pressure and 65 per cent. in the high-pressure cylinders they have succeeded in hauling 135 gross tons up the same grade of 2.6 per cent. at a speed of 25 miles per hour. The maximum speed thus far attained is 65.25 miles per hour. The engine has been run over curves of 984 ft. radius at a speed of 53 miles per hour.

THE BALDWIN-WESTINGHOUSE COALITION.

Since our last issue an alliance of the Baldwin Locomotive Works with the Westinghouse Electric Manufacturing Company has been announced. The combination, it is said in the Philadelphia papers, is not a consolidation of their great companies, but "an industrial combination," in which both companies will mould their resources to a common end. The Baldwin Company will build the running gear, etc., of electric motors, and the Westinghouse Company will supply the electric apparatus. Mr. David L. Barnes, the well-known mechanical engineer, has been appointed a joint engineer for the two companies, and seems to occupy the position of a sort of mechanical umpire in the great game which is thus opened.

The Baldwin Locomotive Works are, of course, well known as being the largest locomotive works in the world. The Philadelphia *Press* gives the following particulars about the Westinghouse Company :

"The Westinghouse Electric & Manufacturing Company was incorporated in 1891 for the manufacture and sale of machinery and appliances for the generation, transmission, and utilization of electricity. The plant of the concern is in Pittsburg, and employs 4,000 men. The Company also operates under lease agreements the factories of the United States Electric Lighting Company, at Newark, and the factory of the Consolidated Electric Light Company, in New York, in the name of the Sawyer-Man Electric Company, employing at these plants an average of 800 men.

"The capital stock is $10,000,000, of which there is preferred and assenting $9,727,450, and common stock (outstanding), $272,550. Its charters, franchises, and patents are estimated to be worth $4,379,831.69. The total assets at the last statement were stated at $14,722,314.48, the surplus being $3,822,049.38.

"George Westinghouse, Jr., is the President; Lemuel Bannister, of Pittsburg, First Vice-President and General Manager ; George W. Hebard, New York, Second Vice-President ; P. F. Kobbe, Treasurer ; Charles A. Terry, Secretary and Attorney, and P. H. Kecham, Auditor. The Directors are : Charles Francis Adams, Boston ; Lemuel Bannister, A. M. Byers, George Westinghouse, Jr., Pittsburg ; August Belmont, Marcillus Hartley, George W. Hebard, Henry B. Hyde, Brayton Ives, New York, and N. W. Bumstead."

"The kind of locomotive," it is said, "which the combined plant of the Westinghouse and Baldwin Companies will produce will be practically of the same type as the experimental locomotive used on the New York, New Haven & Hartford Railroad, on the Nantasket Beach extension. A locomotive of similar construction will probably be adopted on the Burlington & Mount Holly branch of the Pennsylvania Railroad, upon which the overhead electrical equipment has been adopted as an experiment."

Doubtless the two companies will be guided by the development of the science and the art of what may be called electric motivity, and it would be very unlike Mr. Westinghouse if he did not make some important improvements in electric motors if he undertakes to design or build them.

This combination seems to be an official notice "sealed, signed, and delivered," that electric locomotives have come to stay, and are expected to arrive in large numbers in the future, and to "abide with us."

THE RAILWAY RACE TO ABERDEEN.

By Charles Rous-Marten.

Seven years have passed since the famous railway race from London to Edinburgh excited the interest of the whole civilized world. A new race to Scotland is now proceeding without any loud flourish of trumpets or special glorification in print, yet it is a far more important trial of strength and on a scale of far greater magnitude than its predecessor of 1888.

The race is between the East and West Coast routes. The Midland Line does not enter into the competition. Greater distance and severer grades put it virtually out of the running. But the East and West Coast routes are fighting out the matter to the bitter end, and with a grim and silent determination that seems to bode a tough and prolonged struggle.

It is not quite easy to understand how or why the contest started. Something of the kind has seemed inevitable ever since the completion of the Forth Bridge and new Tay Bridge gave the East Coast a shorter road by 17 miles, with easier gradients than those of the West. But the prospective combatants appeared to hang back, each unwilling to be the first to begin the fray and to disturb the blissful peace which had so long prevailed. For "the land had rest seven years"—ever since the race to Edinburgh in 1888.

Up to July 1 the respective transit times from London to Aberdeen were : East Coast, 11 hours 35 minutes ; West Coast, 11 hours 50 minutes. But on July 1 the West Coast unexpectedly shortened the time by 10 minutes. The East Coast promptly replied by bringing down its time to 11 hours 20 minutes. Thereupon, on July 15, the West Coast made a bold stroke, and suddenly announced that 40 minutes would be knocked off the time to Aberdeen at one fell swoop, bringing it down to 11 hours exactly for the 540 miles. The East Coast companies instantly took up the challenge and cut down the time for their 523 miles to 10 hours 45 minutes. That was on July 22. The rejoinder was swift. The West Coast began on the same day running its trains in 10 hours 35 minutes. Once more the East Coast picked up the glove and replied with a reduction to 10 hours 25 minutes, but the West Coast made a simultaneous shortening to 10 hours 20 minutes.

Further accelerations are, however, highly probable. An ultimate consequence is, of course, inevitable, because neither side can arrange finality. But each side has still several cards to play before all competitive possibilities are exhausted. Indeed, on one occasion certainly, if not more, the run has been made in 10 hours or less.

In the first place, it should be clearly understood that the two routes are far more nearly matched than is generally supposed. It is commonly, and not unnaturally, imagined that a route shorter by 17 miles and having easier gradients would confer on the East Coast so great advantage as to render competition hopeless on the part of the West. Not at all. The East Coast, though a shorter and more level road, is handicapped in several respects. It has the troublesome "back shunt" of Newcastle, many miles of single line, and numerous awkward curves on the North British section, shorter runs without a halt, an additional stop, and the necessity of running the last 40 miles or so on the hostile road ; while the West Coast has longer runs through the use of the water troughs and scoops, and is free from all those drawbacks just set forth. So, on the whole, the West Coast is perhaps the easier route to work, and hitherto the proved facts have supported that *à priori* theory. This will be readily perceived on perusing the figures shortly to be given.

On July 15 the East Coast express, leaving London at 8 P.M., was timed to reach Aberdeen by 7.20 A.M., the West Coast train leaving at the same time was due at 7 A.M. The former was in punctually, but when it arrived the West Coast train had already been at the Aberdeen platform 34 minutes. Next day the East Coast train again came in punctually at 7.20 A.M., but the West Coast train arrived 39 minutes before its due time—*i.e.*, at 6.21 A.M., or 59 minutes before its rival. Other

West Coast arrivals during that week were at 6.35, 6.28 and 6.43, the nominal arrival time nevertheless remaining at 7 A.M.

It was on July 22, however, that the race began to assume its closest and most interesting phase. On that evening the 8 P.M train from King's Cross was booked to reach Aberdeen at 6.45 A.M., but the same morning the West Coast express was announced to arrive at 6 35 A.M., or 10 minutes earlier than its rival. There was a general understanding that each line would do its best to beat the other to the Kinnaber Junction, whence both have to travel on the same rails, and where, consequently, though 40 miles from the goal, the race is already decided by priority of arrival and precedence of passage.

Chief interest on that occasion attached to the East Coast train, and a large crowd assembled at King's Cross to witness its departure, as a rumor had gained wide currency that a special effort was to be made to score a record. The load consisted of nine six-wheeled E. C. J. S. coaches, one six-wheeled sleeping car, and one eight-wheeled sleeping car—total weight, 179 tons, exclusive of engine and tender. The locomotive was one of Mr. P. Stirling's celebrated 8-ft. "singles," No. 545. Two strokes of ill luck were encountered, by which fully 12 minutes were lost. At Essendine—midway up the Stoke bank—the train was stopped by signal, owing to the tail lamp being out. This caused a loss of six minutes. Later, a bridge being under repair, two stops had to be made to shunt on to the up line and off again, as only a single line was working. This lost six minutes more; and the two delays practically spoiled the run.

From Grantham another 8-ft engine, No. 775, took the train on to York in 87 minutes, and thence a Northeastern 7 ft. 7 in. single, No. 1,518, continued the journey to Newcastle, making the run in 92 minutes, notwithstanding the loss of six minutes through the bridge repairs already mentioned. At Newcastle two engines came on—a 7 ft. 7 in. single compound, No. 1,525, and a new 7 ft. coupled, No, 1,625—and these ran the train without a stop to Edinburgh (124½ miles) in 2 hours 16 minutes, arriving in 7 hours 39 minutes from London. Thence No. 211, a new North British 6 ft. 6 in. coupled, took the train the rest of the way, reaching the Aberdeen ticket platform at 6.39 A.M., just one minute after the West Coast train had entered the station, where the East Coast train finally landed its passengers at 6.44, having thus accomplished its journey one minute under time, and yet being beaten by six minutes.

It will be interesting to take next one of the West Coast runs, made while the same times were in force. In this instance the load was a light one, consisting of one eight-wheeled sleeping car, three ordinary eight-wheeled W C. J. S. coaches, and one six-wheeled van; total, approximately 112 tons exclusive of engine and tender. The special feature of the route consisted in the remarkable length of the runs without a stop. The first was from Euston to Crewe, 158 miles; the second, Crewe to Carlisle, 141¼ miles; the third, Carlisle to Stirling, 117¾ miles. Thus a total distance of 417 miles was run with only two stops, a feat never before equalled in Great Britain, and of course only practicable through the use of Mr. Ramsbottom's pick-up scoop and water troughs.

The engine at starting from Euston was the *Mercury*, one of Mr. Webb's 6 ft. 6 in. coupled of the *Precedent* class, whose excellent work I have recently had occasion to record in these columns. The first hour's performance was in some respects without any parallel in my experience. During those first 60 minutes a distance of 58½ miles were covered, the greater part of which is uphill. Even with a load of only 112 tons, to maintain a speed of 60 miles an hour for many miles up a rising gradient of 1 in 330, as was done on this occasion, is a feat unique in my observations. Thus the 10½ miles uphill from Watford to Berkhampstead were covered in exactly 10 minutes 30 seconds, and Tring—31¾ minutes--was passed in 35 minutes 17 seconds from Euston, Bletchley—46¾—in 48 minutes 58 seconds, and the 58½ mile-post in exactly 60 minutes. That the engine was being pressed to its utmost was plainly perceptible, but—the work was done. At this point the speed was "eased off," and the rest of the journey to Crewe was performed at a very moderate pace, the 99½ miles of extremely easy road occupying 1 hour 57 minutes. Crewe was thus reached in 2 hours 57 minutes 35 seconds from Euston. Here another *Precedent*, the *Hardwicke*, came on, and once more a remarkable "spurt" was made at starting, the first 26 miles being run in 25 minutes. And here again there was then an easing off. After Wigan was passed the train merely ambled along to Carlisle, reaching the station at 1.52.29—*i.e.*, in 2 hours 49 minutes 55 seconds from Crewe.

At Carlisle a Caledonian engine took charge, No. 90, one of the fine 6 ft. 6 in. coupled bogies designed by Mr. D. Drummond. Some exceedingly smart work followed. Beattock Summit 49¾ miles, was passed in 57¾ minutes, the speed never falling below 34 miles an hour up the long bank of 1 in 75. Carstairs, 73½ miles, was passed in 80 minutes from Carlisle, and Stirling, 117¾ miles, was reached in 2 hours 11 minutes. The hilly run of 33 miles thence to Perth was done in 39½ minutes. At Perth another 6 ft. 6 in. bogie. No. 66—the first of the class ever built—took up the running, and did the 32½ miles to Forfar in 33¾ minutes, finishing with the 57¼ miles of up and down road to Aberdeen in 65 minutes. The train arrived at Aberdeen by 6.43, or 17 minutes before time.

Next came the response of the East Coast on July 29, the first occasion on which a train has ever been timed to reach Edinburgh in 7½ hours from London, or Aberdeen in 10 hours 35 minutes. Once more considerable excitement prevailed at King's Cross terminus, the engine being literally mobbed by admiring spectators, and railway magnates being plentiful as blackberries on the crowded platform. On this occasion the work laid out was far more severe than had ever before been prescribed for a Great Northern engine, taking into consideration the load and the speed. Grantham was to be reached in 1 hour 56 minutes, and York in 3 hours 28 minutes. This was not surpassed even in the race to Edinburgh in 1888, when the loads were comparatively light. In the present case the load again numbered 11 vehicles, weighing 179 tons, equivalent practically to fifteen 12-ton coaches, or 18 of the coaches which at the Newark brake trials were used for the "15-coach test." The engine employed was No. 874, one of Mr. Stirling's 7 ft. 7 in. singles, with inside cylinders (18 × 26 in.), and no bogie. It may be remembered that other engines of this admirable and very economical class have 18½ in., 18¾ in. and 18⅞ in. cylinders, so that this was one of those having smallest tractive force. Nevertheless it proved more than equal to the heavy demand made upon its capacity. The two-mile bank of 1 in 105 and 1 in 110 out of King's Cross and through the two tunnels was ascended without assistance, and the Potters Bar summit (12¾ miles) was passed in 18 minutes 43 seconds; Hitchin (32) in 37 minutes 10 seconds; Peterborough (76¼) in 79 minutes 20 seconds; and Grantham (105½) was reached in 1 hour 52 minutes 44 seconds, a remarkable performance with so heavy a load. Here No. 1,002, an 8-ft. single, but not one of the newest and larger class, came on. Newark (14¾ miles) was passed in 15¼ minutes from the fresh start; Retford (33¼) in 34 minutes 57 seconds; Doncaster (50¾ miles) in 51 minutes 59 seconds; the arrival at York (82¾ miles) being in 85 minutes 59 seconds from Grantham. The complete run from King's Cross to York was thus made in 3 hours 23 minutes 42 seconds.

At York an additional coach was attached, making the total load 195 tons, with No. 1,522, one of Mr. Worsdell's celebrated 7 ft. 7 in. singles, originally a compound, but now I believe converted into a non-compound. A mistake was plainly made here in not taking a pilot, for time was steadily lost all the way, until on passing Durham the loss was no less than eight minutes. Down hill to Newcastle a minute was pulled up, but the arrival there was still seven minutes behind time. Two engines then came on, Nos. 1,621 and 1,525—the one a 7-ft. coupled, the other a 7 ft. 7 in. single as in the former case—and a very fine run of 2 hours 15 minutes was made to Edinburgh (124½ miles), but the complete trip to Edinburgh was spoiled by the needless loss of seven minutes on the York-Newcastle length.

A division was made at Edinburgh, and No. 212, another of the powerful new North British 6 ft. 6 in. coupled bogies, built by Mr. Holmes, took on the 147½ tons still left. Dundee (59¼ miles) was reached as before in 70½ minutes, and Aberdeen ticket platform at 6.19 A.M—*i.e.*, in 10 hours 18 minutes from London. But for the loss of time above noticed, Edinburgh would have been reached in 7 hours 25 minutes, and Aberdeen in 10 hours 12 minutes.

Lastly, I must chronicle the most remarkable, though not the quickest, performance by the West Coast route—that of July 26 and 27. On that occasion the load practically equalled the average of the East Coast, consisting of three eight-wheeled sleeping cars, four ordinary eight-wheeled W. C. J. S. coaches, and two six-wheeled coaches, making up a total approximate weight of 195 tons. Only one engine was used—*Eamont*—a Ramsbottom "Newton" rebuilt as a *Precedent.* Necessarily the time for the first hour was slower than on the previous occasion, with a load so much heavier, but even so the 10½ miles uphill from passing Watford to passing Berkhamstead were run in 10 minutes 58 seconds, and Tring was passed in 28 minutes 17 seconds from Willesden (26¼ miles), while Rugby (82½ miles) was passed in 90 minutes 11 seconds from Euston; Tamworth (110) in 1 hour 59¼ minutes; Stafford (133½ miles) in 2 hours 25 minutes 44 seconds; Crewe being reached in 2 hours 55 minutes 36 seconds. At Crewe, the *Hardwicke*, as before, took up the running, but assisted this time by a pilot, *Princess Royal*, one of the 7 ft. 6 in. singles of the *Problem* class, built more than 30 years ago. Warrington was passed in 26 minutes 20 seconds (24¼ miles), but two slacks—one for

road repairs and the other for signals—caused quite four minutes delay, so Preston was not passed until 58 minutes from Crewe. The distance of 58½ miles from Preston to Shap summit was run in 71 minutes 49 seconds, and a very steady descent of the subsequent down gradient brought the train to Carlisle in 30 minutes 24 seconds more, the arrival being at 1.41.24, or 2 hours 40 minutes 13 seconds from Crewe.

Two Caledonian engines, Nos. 91 and 78, both 6 ft. 6 in. coupled Drummond bogies, now assumed the lead, and a very striking piece of locomotive work succeeded. The run of 117¾ miles without stop to Stirling was accomplished in 2 hours 4 minutes 59 seconds; Lockerbie (25¾ miles) was passed in 27 minutes 27 seconds; Beattock (39¾), in 40 minutes 26 seconds; Beattock Summit (49¾), in 55 minutes 56 seconds—the lowest speed up the incline of 1 in 75 being 33 miles an hour—and Carstairs (73½) in 77 minutes 17 seconds. At Stirling the pilot was dropped, and the distance thence to Perth (33 miles) occupied 40 minutes 55 seconds. No. 70 next came on, and ran that heavy load to Forfar (32½ miles) in 37 minutes 16 seconds, in spite of rain and stormy cross winds; also Forfar to Aberdeen (57¼) in 63¾ minutes against like disadvantages. The train arrived at Aberdeen ticket platform at 6.26, having made the journey of 540 miles from Euston in 10 hours 26 minutes. Of this distance a pilot was used for only 258 miles, the other 282 miles being accomplished with one engine on a load of 195 tons—a very noteworthy record.

It will probably be asked what maximum speeds were found necessary for the performance of this remarkable work. My answer is that in no case was any higher velocity attained than I have noted times without number by the ordinary express trains on the respective lines, nor were my previous recorded maxima either attained or closely approached. The East Coast once touched 80 miles an hour, the West Coast 78; but as a rule the running speed was somewhere about 60 miles an hour, very evenly maintained, and rarely exceeded 70 to 72 miles an hour under the most favorable conditions. The feature of the race, as in that of 1888, has been the maintenance of high velocities for long distances and uphill. When the loads and conditions are compared with those of the race of 1888, it will be recognized that the locomotive work of the present season has been enormously superior. On that occasion very light "specials" were run at average and maximum speeds which have often been equalled by heavier ordinary expresses over particular lengths of the lines, whereas in this case it is the ordinary heavy expresses that have achieved such splendid results.

As to the question of safety of travelling, I may observe that only those who are ignorant of the conditions involved have any doubt on that point. All who understand what is essential to safety and what is actually done recognize that to raise such a doubt at all is absurd. If, then, "racing" expresses are unsafe, so is every decent train that runs, indeed, more so, for in this case special precautions are taken to keep the road clear so as to avoid even the slightest delay.

With regard to the matter of ease in running, my experience is that with these trains—on both routes—as in former instances of fast work, the steadiest running is at the highest velocities. In one case some slight oscillation was set up at 53 miles an hour, and reached its maximum at 57 to 58. When the speed reached 60 the oscillation decreased, and at 65 miles an hour it had ceased altogether. At 70 to 75 miles an hour the steadiness was absolute. At the same time the superiority of "bogie" coaches to six-wheeled stock has been made very apparent, and the lesson will doubtless bear fruit.

As to the engines, it is worthy of note that the 6 ft. 6 in. coupled type performed the entire work on the West Coast—except as regarded occasional pilot assistance—while 7 ft. 7 in. or 8 ft. 1 in. singles did that of the East Coast as far as Edinburgh, with the aid of 7 ft. coupled pilots over the last stage, 6 ft. 6 in. coupled engines then continuing the journey to Aberdeen. Once more is noticeable the remarkable uniformity of excellence in the actual work of widely differing British locomotive types.

It may be worth while to add that several "record" trips with light loads were made on the West Coast route with five coaches. Aberdeen was reached on three successive days at 6.14, 6.5 and 5.59 A.M. by the trains which left Euston at 8 P.M.—that is to say, in 10 hours 14 minutes, 10 hours 5 minutes and 9 hours 59 minutes respectively. These are brilliant achievements, though, of course, as specimens of locomotive work they bear no comparison with that accomplished with heavy loads, as set forth in the preceding notes.

That it is quite feasible to run with a light load from Euston to Carlisle at the average rate of 60 miles an hour has already been demonstrated, probably the remainder of the journey could be completed at a like rate. The East Coast train, were it equally light, could assuredly go to Edinburgh at the same speed. But I doubt the feasibleness of any material acceleration north of Edinburgh under existing conditions.

Whatever may be the outcome of this curious rivalry, no one will deny that the achievements of the competing lines constitute a fresh and brilliant epoch in railway history.—*The Engineer.*

Since the above letter was published in *The Engineer* a dispatch from London announces that a West Coast train, which left Euston Station at 8 o'clock on the evening of August 20, arrived at Aberdeen at 4.58 the following morning, making a running time of 538 minutes, which is, we believe, the shortest time on record for a long run. This is a fraction over 60 miles an hour for the whole distance, including stops, so that when the delays for slowing down, station stops and changing engines are made it will undoubtedly be found that the actual speed attained will be close upon 80 miles an hour, if these figures are not actually exceeded. Heretofore the Empire State Express of the New York Central & Hudson River Railroad has been the fastest long-distance train in the world. Its running time from New York to Buffalo, a distance of 440 miles, is scheduled at 520 minutes, of which the time-table shows a loss of seven minutes, three at Albany and four at Rochester, with additional stops at Utica and Syracuse. Making no allowance for stops, the average running time is 50.77 miles an hour. If such an allowance is made the average running speed is raised to 52.36 miles an hour. In making this comparison between the American and the English train, it must be remembered that the time of the Empire State Express is one that is made day in and day out for the whole year, irrespective of the weather, the condition of the rails and other variables that may tend to retard the speed of a fast train. If the West Coast Line puts on a regular train to do this work throughout the whole year and then maintains its schedule with the train on time, it will be an achievement of no mean magnitude. In the interests of possible locomotive work, it is to be hoped that this will be done, and that the rival roads will not be tired out with their efforts—as they apparently were in 1888—and be content to show what they can do at a spurt, and then tacitly acknowledge that they do not care to put forth the effort to maintain the pace. But, weather conditions excepted, there seems to be no good reason why, if the engines are maintained in perfect working order, what has been done on these racing runs cannot be kept up as a part of the regular working of the road.

LOCOMOTIVE PISTON-RODS.

THE designer starts with a 3-in. rod (7 sq. in., say, sectional area), and then thinks he must, by hook or crook, get his 7 sq. in. net section through the cotter-hole as well—*i.e.*, he thinks that nothing less is strong enough, whereas if we were to take any engine at random and find the body of rod had 7 sq. in. and the cone 5¼, instead of worrying ourselves about the latter not being strong enough, we could safely reduce the former down to 5¼, provided we retained the same moment of inertia by making it hollow; in fact, if the engine could suddenly be converted into a single-acting (tensional) engine, we might at once put in a solid rod of 5¼ sq. in. section. There certainly seems something very truistic about this; but consider an average man getting out a new motion; say 3-in. rods have always been used, but with solid crossheads, and that now it be proposed to put on loose cottered ones; starting them with a 3-in. rod, he proceeds straightway to make his coned end of the same section as the rod itself, a bit of superficial reasoning resulting from having confined his attention merely to the question of strength; assuming then this desire on his part for equal strength, he has forgotten (1) that the rod may be ultimately turned down to 2¾ in. before scrapping; he thus assumes a rod 20 per cent. stronger than in reality (and, although irrelevant to this argument, 30 per cent. stronger against buckling), for this 2¾ in. *is* the virtual size of the rod; (2) that the rod, being a hinged strut, requires to be stronger in the body than in the cone; for if the latter is well fitted up, it is only subject to direct stress, and therefore is stronger proportionally than the body, as the stress is not distributed uniformly over the latter's section, owing to flexure. What I am driving at is this: He wants to get his coned part strong enough for the job, and to that end makes it equal to the 3-in. section, whereas, for the two reasons above, he should *not* take 3 in. as his basis.

As far as strength goes, it is absurd to worry about making the coned end equal to the body, especially the original size of the latter. Given a certain diameter of rod as suitable for a given engine, we can safely turn the end down for the required cone, and rest assured that it is *per se* quite strong enough for its work. But the mischief (theoretically, at least) occurs directly we couple it on to a stronger section than itself, because all the stretch will come on the weaker one; it is not

likely that a 7-in. section is going to do much stretching when there is a 5-in. one conveniently contiguous.

Of course *this* is the real point to be borne in mind, and the designer of a swelled end, who put this forward, would be showing just cause; but I fancy it is generally lost sight of; in fact, they consider the matter of strength and ignore that of elasticity; in a word, if I *were* to enlarge an end it would not be that I wanted to make the end as strong as the body, but that I did not want the body *to be stronger* than the end; there is a distinction here *with* a difference.

It is, of course, a very elementary fact that it is desirable to retain a uniform section throughout, so as to distribute the "stretch" equally all through. And this would lead us to entertain the idea that it would be of advantage to elongate the cotter hole—that is, give it 1 in. or 1½ in. "draw" instead of the usual ½ in.; it would undoubtedly be all the better for it; the only objection that I can see is that we should not get so tight a conical fit, as the sides of the cone would yield. As to elongating the hole, I merely mention it for what it is worth; but if I ever *were* troubled with rod-end failures, I should look first to the material and workmanship, and *then*, rather than enlarge the end, should try the efficacy of lengthening the cotter-hole, bringing it up to the mouth of the crosshead.

The best way would be to drill out the piece next to the crosshead first, giving it about $\frac{1}{16}$ in. taper; plug up fairly tight (riveting over slightly on bottom side), and then traverse out the cotter-hole. We should then, when fitting in, get a solid resistance to the compressive reaction of the crosshead, and at the same time get a longer reduced section to take up the stretch; at any rate, I should be inclined to do something of this kind before falling back on the good old time-honored "If it breaks, make it bigger" doctrine, which, I fancy, has done yeoman service in its time. The extra shilling or two cost would be well laid out, I think. I have often wondered to what extent the expression "interchangeability of parts" is taken literally; I believe a good many non practical engineers do accept it as being literally true. Well, no fitter, I should think, would dream of taking a little or big end brass, or an axle brass, out of one engine, and putting up in a sister one without a preliminary try on; much less, indeed, should he think of changing a crosshead cotter without trial; and if he does try over the cotter, it is no use smashing it down for all he is worth, and then drawing and serenely examining it, although it will be lucky to get even this attention; the proper thing is to emery-paper the edges and knock in lightly, just enough to mark it; if it shows a fit all through, you may then bang it down with a light heart.

If the cotter were $\frac{1}{32}$ in. out in its length (that is, if, instead of a taper of ½ in., it has ½ in. ± $\frac{1}{32}$ in.), it might make a fit for itself with a lot of persuasion—that is, plenty of driving down, but it will be at the expense of the fibres of the rod-end, top or bottom as may be; but if, when allowed to go, there is still a space of $\frac{1}{64}$ in., say, at the bottom end; then it will work in the hole, and that $\frac{1}{64}$ in. will very soon take unto itself another $\frac{1}{64}$ in., and the last state of that cotter will be worse than the first; in short, you will find the edge of the bottom half grooved, and pretty well intact on the top half where there has not been the fore-and-aft knock in the hole. In anticipation of certain probable criticisms, I may ask of what use *are* designs unless properly carried out—that is, fitted up properly? It is one thing, sir, and so easy, too, to show on paper a cotter having a mathematical fit in the hole, and quite another thing to attain it. So you see that, after all, success *does* ultimately rest with the workman. You may say that minute instructions of this nature are not expected to be shown on a drawing; that a draftsman is not supposed to tell a fitter his business; no, and for a very good reason, too, generally speaking. I often call to mind what a pupil once remarked to me when together in the shops. The question arose as to whether it was desirable, or necessary, for the heavily premiumed ones to attain any greater degree of manipulative skill at the vise. He argued that it was not necessary for them to be able to *do* a job, but only to know how it was done. Well, it does not take workmen long to know their man. To go back a bit, I think with a detail like this (*i.e.*, a piston-rod), which is a rather fruitful source of failure, one cannot take *too* great pains. It is one thing to fit a brass in an axle-box, and another to cotter up a crosshead. This is, therefore, a detail that shed fitters ought to receive a gentle reminder to be careful with. We know that a good many of their jobs are done in a rush; anybody who has been on the repairs bench (on connecting-rods, say), knows that a lot of his work is due to shed-fitting.

I was once looking at an engine in a certain station, and noticed that the crosshead cotters had ½-in. draw; the hole in the top of the crosshead was about 2½ in. long, and the cotter only 2 in. Well, it was very certain she had not been designed like that; $\frac{1}{16}$ in. would be ample. Either the crosshead or the rod had been changed, and I should have concluded that the rod end had proved too big for the hole, and so only able to take the 2-in. cotter; but as I could not see any shoulder standing out from the crosshead, I knew that the end had gone right up, and it was therefore the cotter-hole that had been set back too far from the end of the rod, so that the original size cotter would not enter. There was, of course, the chance that the rod and cotter were right and the crosshead at fault, so I made it a point to look out for others of the same class, and I found their cotters were about 2½ in. wide, so those I first saw were about 20 per cent. below their proper strength. As a matter of detail, it was not at all likely to be the crosshead that was wrong, because we can very safely assume that if it *were* so, it was not the original one off any of the same class, but a renewal, and crossheads do not fail so as to require replacing *every* day; whereas it is a very common event to put new ends on rods, when they are iron at least; and I can *quite* imagine instruction being thoughtlessly given to set the cotter hole back a bit from the end, so as to leave more metal there—that is, supposing this to have been the point of failure. I was once told of an official, drawing his $3,000 a year, who gave orders to put a blast pipe in a certain engine 4½ in. *full;* if he would do that, he would do the other.

As to the cotters alluded to above, you may or may not expect to get scientific engineers for $1.50 a day, although, of course, there was absolutely no excuse whatever in this case, for, leaving the crosshead out of the question, the fitter could have seen that the cotter did not tally with the rod. But this engine remained like it for some months to my knowledge, and so people who were drawing one or two $1.50 daily from a grateful company had had time to see it.

It did not fail then? Oh, no; not as far as I know. But that is no argument; I dare say we might go round to a good many bridges and other structures to-morrow and abstract half the metal (or I had better say half the strength), and still they would stand and do their work, too; but it is *usually* thought advisable to make such things 400 or 500 per cent. stronger than the bare failing strength. I *have* known, though, of a brass gear (of all things) working up to a stress of 14 tons per square inch; that was only the static load, either; considering that there was no compensating gear, and the sometimes sudden application of full pressure, I do not fancy there was much margin of safety *there.* I expect it was got out "by the eye"

Tail Rods —I am in favor of these caudal appendages, but object to their weight. It certainly seems extraordinary that makers should put in solid ones if they are alive to the importance of light reciprocating parts. "Novoye Vremya" said he had tried tubular ones, but had had trouble with them. We could see what section we required, and add on, say, $\frac{3}{16}$ in. to the diameter, to allow for truing up; tubes can be got thickened at the ends either inside or out; and we should use a fine thread. The tube could be either pinned on, or sweated, or both. Or you could leave the rod end long (about the same length as shown screwed) and weld the tube on; this answers all right for some of Joy's valve gear rods; and Stroudley did it with his pump rams; and they had severe axial stress to put up with which these tail-rods would not be subject to. Taking a piston head, rings, and nut with the liberal weight of 160 lbs., and finding the maximum bending moment, allowing for partial weight of piston and tail-rods, and regarding them as only "supported," I find that an iron tube 2¼ in. external diameter and ¼ in. thick would do; say 2½ in. external to begin with; that allows ⅛ in. a side for turning down; an amount that would see out the lifetime of a good many engines one could mention; and, as far as calculations go, the deflection would be insignificant. Taking the tail rod as 32 in. long, and allowing for the solid part common to both designs, the weights would be roughly 15 lbs. and 40 lbs.—a saving of 62½ per cent. in the weight. The pin should be well up to the back end of the tube; it is as well to keep it away from the packing, with an eye to future fitting, in case it is ever unshipped.

The small side of the pin-hole can be countersunk nearly the whole thickness of the tube (about one-eighth larger at the mouth) and riveted over; the pin will then hold, however the rod be turned down. I have set the pin horizontal, affecting the strength least in that position; as to the piston nut pin, it does not matter how that is put, though they are usually all made to stand one way, for sake of appearance. Talking of appearance, some people set their crosshead cotters with the front edge at right angles to the axis of rod; others set the back edge so; I do not think there is much in it, whichever you do; and it most decidedly looks better to set the cotter itself square with the rod. In favor of putting the front edge square you could certainly argue that it gives same resistance of crosshead top and bottom in front of the cotter; it most cer-

tainly looks better than when set the other way, which gives the maximum difference in this respect—that is, with cotter of 1 in 16 taper, and 6 in. diameter of crosshead, we should have, say, 1⅝ in. in front of cotter and 1⅜ in. at back. As I have it, there is half this difference. What *is* in their minds is some idea, I suppose, of extra security against the cotter working back—that is, when the split cotter hole is knocked right through. One thing is very certain—you ought to have a small taper on the cotter, as it will soon knock through and lose the support of the split cotter; and yet, on the other hand, the smaller the taper the sooner the cotter *will* knock through; they might have a double row of split-pin holes 1 in. apart horizontally, set hit-and-miss, say, 1 in. or more up the cotter, if they prefer this to a long split cotter hole; at any rate, you ought to obviate any likelihood of the main cotter being able to slack back when knocked through ½ in. or more, although I have seen the split cotter through a clear 1 in. many a time. But the main cotter had only 1 in 96 taper on each side, so it was pretty secure, and things are all right while they *are* all right. But no one would like to let a connecting-rod cotter go without its set screws, which are really *the* sheet anchor (for all the good split pins and cotters are for such purposes, they might as well be left out). Why, then, run the risk of the crosshead cotter being in same condition?

Thrust of Piston Opening Crosshead.—This could easily be experimented upon. Cotter up a rod and apply a 20-ton thrust and see how much the rod moves up into the crosshead, either by direct measurement or by observation of the cotter. A very slight inward movement of the rod would be apparent to the man who had cottered it up, either by the way he could drive the cotter a bit more, or else draw it out. This gauging, however, is not quantitative, and perhaps would not be accepted as proof. But we could cotter up and then hang a few hundred weights on to the cotter, and then apply the thrust; if we had, say, a 1 in 25 cotter, a movement of $\frac{1}{200}$ in. would drop the cotter ⅛ in. If the pressure were put on quietly and *all jerks obviated*, there could be no doubt as to the crosshead having fairly yielded. However, as I said before, one can easily satisfy himself in any specific case (of actual working) by drawing the cotter and examining the edges.

Valve Spindle Sockets.—There ought to be a taper pin hole at back end of socket, for the purpose of starting the spindle when disconnecting; the pin would be about ¼ in. and $\frac{5}{16}$ in.; it is very seldom adopted, but it ought to be; if it is not there, the socket will have to suffer.

In connection with drawing out the rod, there is one point that might advantageously be looked after; when turning up an old rod, I should ease the end a bit where it does not enter the packing; the parallel part I mean; the turner could easily note the length of the unworn part and give it a good easing, the last thing; the shed men would hold his name blessed when next taking it down, especially if much worn and with *some* metallic packings. I have seen valuable hours wasted getting out valve spindles that had worn a lot; of course they had been turned up scrupulously parallel all along, and being from $\frac{1}{32}$ in. to $\frac{1}{16}$ in. bigger than the middle of the rod (through wear), wanted a lot of drawing. This is such an easy thing to rectify, and yet it is sure to be scoffed at.

I must own that I should be very careful about giving orders for this, if using screwed ends, because I should most decidedly have them bear on a shoulder, as in Vauclain's; well, toward the end of a rod's career there would not be much bearing surface on this shoulder, and a turner might take *too* much off the end of the rod; the only thing would be to limit him, say, to never getting below a bare $\frac{1}{16}$ in. of shoulder. With cottered ends you can leave him alone, he cannot do any harm (at least he must not encroach on the conical fit), and if there *is* a shoulder—well, all I can say is, it ought not to have a bearing on the crosshead.

Turning Down Rods for Wear.—I gave ½ in. a side as a maximum, a very liberal allowance too; an amount that would, with average rate of wear, last out most engines. As to prolonging the cone into the rod, I would suggest this for renewals of existing engines where they admit of it; in getting out a new one, I should grudge any more clearance than actually necessary, say ¼ in. between the face of the crosshead and the ends of the gland studs; any more than this is only unduly robbing the connecting-rod. It is a question, though, if it would not be worth while in the case of solid crossheads or enlarged ends (especially when the latter accompany *some* arrangements of metallic packing) to make this clearance sufficient to enable you to get at the rings without unshipping the piston, in the former case, or drawing the rod through in the latter.

Material for Rods.—I am not particularly in love with very high steels for this purpose, for, with end failures, in the absence of electrical welding plant, the rods would be scrapped. I know of one line that uses about 32-ton steel for their piston-rods; they have a solid crosshead (a forked end, that is), and are therefore expensive rods, yet they are always thrown away for defective ends. Any good smith would undertake to shut an end on such a rod and answer for it. It has often seemed to me that iron rods wear as well, if not better, than steel ones. We might use cold rolled iron and get a few tons extra strength, but we should lose it the first time we put the rod in the fire.

Screwed Ends.—"Novoye Vremya" talks of these breaking short off. I have known scores have the nuts stripped right off, but not the rods break. These averaged 32-ton steel, and the screwed ends were V-thread, seven per inch, 3 in. in diameter over all and 3 in. long; the body of the rod was 2¾ in., thus securing, I suppose, what he wishes; on the other hand, all Webb's are much smaller than the body of rod, as are also Vauclain's, and I never saw one fail. This striving after a hard-and-fast uniformity of sectional area is all very well in its way, but, like many other things, you can overdo it. (I need scarcely say that it is *the* correct thing.) However, if I were designing a crosshead like Webb's, I should most certainly not entail the disadvantages of a swelled end, to gain what your correspondent desires; I should keep the rod flush right along, so as to draw out without interfering with the packing and avoid split glands and bushes; but at the same time I should most certainly put a shoulder on the rod to bear upon the crosshead.

I may as well sum up the points I have insisted on in this letter; (1) and (2) apply to cottered ends only:

1. Insure contact between the end of the rod and the inside of the crosshead at the back end, and see that it bears, if anything, on the outside of the annulus, as there the crosshead is stiffest.

2. Where there is a shoulder on the rod, keep it *off* the face of crosshead. It is a question, though, if it would not be worth while in the case of solid crossheads or enlarged ends (especially when the latter accompany *some* arrangements of metallic packing) to make this clearance sufficient to enable you to get at the rings without unshipping the piston in the former case or drawing the rod through in the latter.

3. With a rod that passes through the crosshead and takes a nut at the far side, *by all means* have a shoulder to bear on the crosshead; this shoulder to have quite ⅛ in. radius.

4. Insure a good job to begin with, especially with a cottered end, and try and have due care exercised in the shed when changing crossheads or rods, to see that the conical fit is all right, and that the cotter is a correct (not merely tight) fit.

5. In the case of *all* pistons, see that there is a collar on the rod to bear up on the piston head. Where the heads are never taken off, secure by a pin. There is nothing to be gained by making a huge hole right through nut and rod. If the head has to be removed for piston examining, or when disconnecting (as in Stroudley's rods), put a pin at the back of the nut, and give it about $\frac{1}{16}$ in. draw in the hole, so as always to keep it up to the nut, for although the piston may not move up further every time, which it *will not* do if the rod has a collar, still the nut will go round a bit further, and if the hole is through the nut it is a nuisance.

Given good material and the observance of these points, I think rod failures ought to become in future conspicuous by their absence.—*Engineering.*

NOTES.

Bicycles are said to have seriously affected the sale of pianos in England. The reason given is that when a girl is asked to choose between the two for a present, she invariably selects the wheel.

The Los Angeles Electric Company, Los Angeles, Cal., use "Stevedore" transmission rope for their drive, and have recently ordered 3,000 ft. for this purpose from the C. W. Hunt Company, New York City, who are the sole manufacturers.

The Gould Coupler Company report that the recent fire in their works at Buffalo, N. Y., was at the forge plant, and had nothing whatever to do with the coupler works. They are now turning out between 500 and 600 couplers a day, and can ship all orders promptly. The forge plant will be running again about October 1.

Lubricating Pulley Block.—At some service tests of hoisting recently made by Robert Grimshaw and Lieutenant John A. Bell at the Brooklyn Navy Yard, it was shown that, when the blocks were lubricated with waterproof graphite grease made by the Joseph Dixon Crucible Company, of Jersey City, a saving of from 30 per cent. to 35 per cent. was effected in the power over that required by unlubricated blocks.

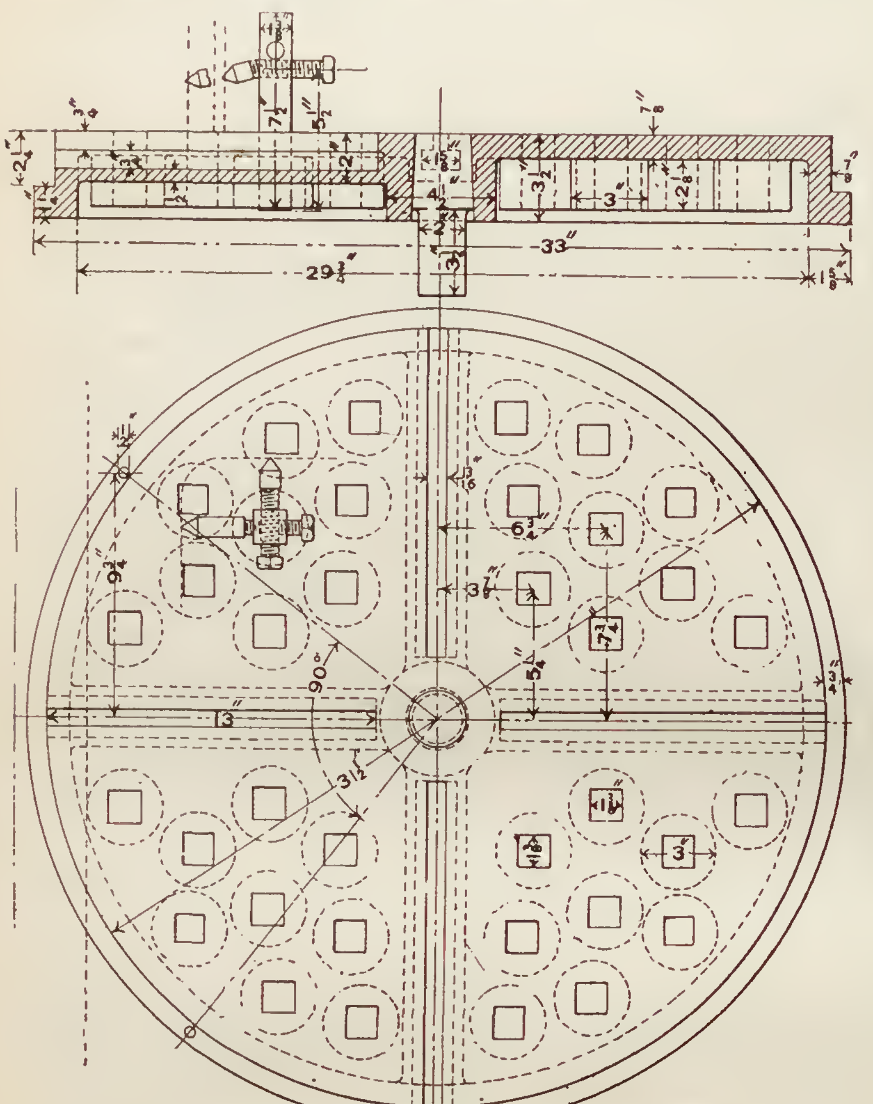
André's Proposed North Pole Balloon Expedition.—A correspondent in Sweden writes us that Mr. Nobel has raised

his contribution to this expedition to 65,000 kroner ($18,000), providing the remaining 65,000 needed for the expedition will be guaranteed by others within two months. It seems probable therefore that this daring expedition may be undertaken before long.

The Largest Sailing Ship Afloat has recently been completed at Bremen. She is called the *Potosi*, is a five-master, 394 ft. long, 50 broad, with a draft of 25 ft., and a carrying capacity of 6,150 tons.

The Abendroth & Root Manufacturing Company, 28 Cliff Street, New York City, manufacturers of the improved Root water-tube boiler, have been awarded the 626 H.P. boiler contract from the Union Car Company, of Buffalo, N. Y., and a 500 H.P. contract from the Reading Steam Heat & Power Company, of Reading, Pa. They are also erecting in New York City 300 H.P. in the College of Physicians and Surgeons, two boilers in the Baptist Home, one boiler in the Parmly Building, and two boilers for the Sing Sing Electric Lighting Company.

A Planer Chuck for Steam-Chests.—There is a handy wrinkle in use in the shops of the Philadelphia & Reading Railroad, at Reading, for holding steam-chests upon the planer while they are being finished. The chuck consists of a circular table, as shown, having a central bearing pin 2 in. in diameter, upon which the device turns. The top face is plentifully supplied with holes for holding the dogs, so that any size of chest can be readily held. The dogs are of the shape shown



A PLANER CHUCK FOR STEAM-CHESTS.

in plan and elevation, and grip the chest at the corners. Two ½-in. pin-holes standing at an angle of 90° with each other, as shown on the plan, serve to hold the table in position. After one side is planed the table is swung through 90°, the holding pin inserted through the other hole, and the chest thus brought into accurate alignment for doing the work upon the other side.

The Willans Central-valve Single-acting Engines made a conquest in London, and are employed for direct driving in a majority of the electric stations there. The evolution of the engine began about 1870 under the constant and able efforts of Mr. Willans, who was a competent steam engineer at the beginning, and an authority on the subject at the time of his death about three years ago. Now has began a struggle between the single-acting and the turbine engines made at Gateshead by Mr. Parsons, and we may also include the De Laval engine, which, however, does not seem to be made in England at this time. This race of motors for dynamo driving is one of much interest, and in London is no doubt typical of what is to follow elsewhere. In this country the horizontal automatic engines have held a large place for direct driving, but are slowly yielding to the vertical or inverted type.—*Industry.*

RAILWAY ROLLING-STOCK.

In a paper read recently before the Institution of Civil Engineers in England, Mr. Alfred John Hill gave some data regarding the wear and durability of railway rolling-stock in that country which will be of interest to our readers as a basis of comparison with the results obtained in the United States.

Boilers.—There is no doubt that the more perfect the condition in which a locomotive is kept, the more efficiently and economically it can do its work; and there is probably no part of a locomotive which requires more attention, or which so assuredly repays for that attention, than the boiler. In the author's opinion an engine will generally outlast two boilers, and every boiler two fire-boxes.

Lap-welded basic-steel tubes, with 6 in. of brass brazed on at the fire-box end, have been almost exclusively used of late on the Great Eastern Railway. They are as a rule 1⅝ in. in outside diameter, being secured by steel ferrules at the fire-box end and expanded at the smoke-box end. Tubes of steel throughout have been adopted by other railway companies. They have been tried on the Great Eastern Railway, but considerable difficulty has been experienced in keeping them tight, whereas the brass-ended steel tubes have given practically no trouble. Owing to the difficulty of tracing tubes after they have been taken out for repairs, definite information as to their life cannot be given.

Every crank-axle on the Great Eastern Railway, after it has run 250,000 miles, is subjected to a special examination, for which purpose all incumbrances except wheels and crank-hoops are removed, all paint is scraped off, and the axle is thoroughly cleansed with spirits. A similar examination is made after every additional 100,000 miles has been run. All axles, whether crank or straight, are also specially watched while being turned, and none are used where the slightest flaw is visible. During the year 1892, 36 crank-axles were, for various causes, condemned on this railway, their average service being about 275,000 miles. In two cases the axles failed while running, but caused no accident to the trains. In 13 cases flaws were discovered in the shops or running sheds. The remaining 21 crank-axles belonged to engines which were either condemned or were being rebuilt with axles of a standard design, but were themselves perfectly sound, the average mileage run by them being 292,619 miles.

Tires.—The life of tires must depend greatly upon the nature of the road, as well as upon the description of the traffic worked and the design of the engine. Unfortunately, in deciding upon the section of rail to be used, engineers do not always sufficiently consider the wearing effect which a comparatively sharp-cornered rail has upon the tires. On one line with which the author is acquainted the flanges of the tires wear so rapidly that it is often necessary to re-turn the tire before it is appreciably worn upon the tread; and upward of ½ in. is sometimes turned off the tread in order to bring the flange to its correct form. In considering this question it must be remembered that, in addition to the cost of the tires themselves and of the work entailed in lifting the engine and turning the tires, etc., the engine is for the time thrown out of service. The tires in general use on the Great Eastern Railway are made of Bessemer steel, having a tensile strength of 40 tons per square inch, and composition shown by the following chemical analysis:

	Per Cent.
Combined carbon	0.350
Silicon	0.083
Sulphur	0.064
Phosphorus	0.047
Manganese	0.605
Iron (by difference)	98.851
	100.000

With a view to increase the life of tires, and also to decrease the proportion of material which is finally discarded, in comparison with that which is actually worn away, it is desirable that new tires should be made as thick on the tread as can be conveniently arranged consistently with the simple design of spring gear, etc. The tender tires on the Great Eastern Railway have therefore recently been made 3½ in. thick, those for the engines being 3 in. thick on the tread. No engine or tender tires are allowed to run when reduced to less than 1⅝ in. in thickness. If, however, when they come into the shop to be turned, it is found that the flange cannot be brought to the right section and leave the tires 1½ in. thick, they are condemned. Engine and tender tires may as a rule therefore be considered to be worn out when they are only 1½ in. thick.

The average mileage of 10 sets of four-wheels-coupled express-engine tires on the Great Eastern Railway was found to be as follows :

	Leading.	Driving.	Trailing.
Mileage	121,351	194,339	194,339
Miles per $\frac{1}{32}$" reduction in thickness	2,528	4,049	4,049
Loaded weight on wheels	Tons. Cwt. Qrs. 14 8 2	Tons. Cwt. Qrs. 14 1 0	Tons. Cwt. Qrs. 13 10 3
Diameter of wheel on tread	Ft. 4	Ft. 7	Ft. 7

The average mileage of 10 sets of six-wheels-coupled goods-engine tires was found to be as follows :

	Leading.	Driving.	Trailing.
Mileage	168,012	168,012	168,012
Miles per $\frac{1}{32}$" reduction in thickness	3,500	3,500	3,500
Loaded weight on wheels	Tons. Cwt. Qrs. 12 8 0	Tons. Cwt. Qrs. 14 0 0	Tons. Cwt. Qrs. 10 2 0
Diameter of wheel on tread	Ft. Ins. 4 10	Ft. Ins. 4 10	Ft. Ins. 4 10

The average mileage of eight sets of six-wheels-coupled suburban passenger tank engine tires was found to be as follows :

	Leading.	Driving.	Trailing.
Mileage	105,444	105,444	105,444
Miles per $\frac{1}{32}$" reduction in thickness	2,197	2,197	2,197
Loaded weight on wheels	Tons. Cwt. Qrs. 12 17 1	Tons. Cwt. Qrs. 13 13 0	Tons. Cwt. Qrs. 13 19 3
Diameter of wheel on tread	Ft. 4	Ft. 4	Ft. 4

The average mileage of six sets of tires on six-wheels-coupled tank-engines similar to the above but used for goods trains, and not fitted with the Westinghouse brake, was found to be as follows :

	Leading.	Driving.	Trailing.
Mileage	216,090	216,090	216,090
Miles per $\frac{1}{32}$" reduction in thickness	4,502	4,502	4,502
Loaded weight on wheels	Tons. Cwt. Qrs. 12 4 2	Tons. Cwt. Qrs. 13 4 2	Tons. Cwt. Qrs. 13 5 2
Diameter of wheel on tread	Ft. 4	Ft. 4	Ft. 4

It will be noticed that the tires of the latter engines ran more than twice the mileage of those of similar engines used for passenger trains. This is no doubt due to the action of the continuous brake, and to the fact that these passenger engines work to a large extent on the Enfield Branch, one of the hardest services on the Great Eastern Railway, where they have to run 10¾ miles with 14 intermediate stops in 40 minutes. Seventeen of these passenger tank engines were fitted in January, 1892, with special hard steel tires having a tensile strength of 48 tons to the square inch, and the results obtained up to their first turning were satisfactory. The average mileage was 47,134 for an amount of wear equal to ¼ in. in thickness, or 5,892 miles per $\frac{1}{32}$-in. reduction. This is nearly three times the duty obtained from the softer tires.

Sixteen pairs of crucible-steel tires have been tried on the driving and trailing wheels of the four-coupled express engine. Only one set had worn out by March 31, 1893, and these had run 202,623 miles. The average mileage per $\frac{1}{32}$-in. reduction in thickness for the 16 pairs up to March 31, 1893, was 4,715 miles compared with 4,049 miles for the softer tires previously referred to. During the three years 1888–90 the consumption of engine and tender tires for repairs and renewals on the Great Eastern Railway was 3,512, weighing 1,407 tons 8 cwt. ; and the engine-miles run (excluding those by "capital" engines) were 58,202,648. This is equivalent to a consumption of 54 lbs. of tire for every 1,000 engine miles ; or taking the average cost of new tires at £10 per ton, and allowing for the credits obtained by the sale of old tires, the cost of engine and tender tires per 1,000 engine miles was about 4*s.* 4*d.*, or 0.052*d.* per mile.

A RIDE ON A DEAN COMPOUND.

Most of our readers are aware that the late J. N. Lauder a few years ago built a compound locomotive of the American type from designs made by Mr. F. W. Dean. After Mr. Lauder's death, and he was succeeded by Mr. Henney as Superintendent of Machinery of the whole New York, New Haven & Hartford Railroad system, the question came up with reference to the merits of compound locomotives generally, and this one particularly. It was then decided to make a practical test of the engine referred to by running one of the trains on the Old Colony Division with it for a month, and then putting one of Mr. Lauder's simple engines on the same run for the same length of time. The run was from Boston to Wood's Holl, a distance of 71¾ miles. The trains consist of about eight cars, and the number of stops are sufficient to make the service a very fair test of the capacity of the locomotives.

While in Boston a few weeks ago, through an invitation from Mr. Dean, we had the privilege of a ride on his engine from Wood's Holl to Boston. The test is under the charge of Mr. Boyden, a son of the former Superintendent of Motive Power of the New York & New England Railroad. No results have yet been reached, and of course a comparison will be impossible until the simple engine has been tested. All that can be done now is to comment on the working of the engine, which is very satisfactory. There is no difficulty whatever in starting, and the absence of a violent exhaust even when working hard is noticeable. The results of the test will be awaited with interest. The only unfavorable comment to be made is that the engine "rides hard." Under certain conditions of working, every revolution of the driving-wheels can be felt in the cab, and is apparently due to the action of the counterbalance, and, if so, should be remediable. The working of the engine is otherwise very satisfactory, and if the anticipated economies are realized will do much to bring this form of compound into favor.

DEATH OF EDWARD F. C. DAVIS, PRESIDENT OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.*

Probably before this number of the American Engineer reaches its readers most of them will have learned through the daily papers of the sad death of Mr. Davis, who was killed in Central Park, New York, while riding horseback, on the evening of August 6. When found he was unconscious, and the

EDWARD F. C. DAVIS.

supposition is that his horse became unmanageable and fell on him.

Mr. Davis was born in Chestertown, Md., on August 13, 1847, and was thus nearly 48 years old. He was educated at and graduated from Washington College, Maryland, in 1866. His business career was commenced in the shops and drawing-

* We are indebted to the *Iron Age* for the portrait accompanying this notice.

room of the Philadelphia Hydraulic Works of Brinton & Henderson. Later he was employed as draftsman at the New Castle Machine Works, New Castle, Del. ; Atlantic Dock Iron Works, Brooklyn ; Athens Brothers' Rolling Mill, Pottsville, Pa. ; and the Colliery Iron Works, Pottsville, Pa. In March, 1878, Mr. Davis made an engagement with the Philadelphia & Reading Coal & Iron Company as Principal Draftsman, and later became Superintendent, and had charge of the shops where all the machinery of their extensive collieries was built and repaired. In 1890 he became Manager of the Richmond Locomotive & Machine Works, and left them in the spring of the present year to take charge of the works of the C. W. Hunt Company, which are on Staten Island, near New York.

Mr. Davis became a member of the American Society of Mechanical Engineers in 1881, and always took a lively interest in its affairs, and was frequently a contributor to its proceedings. From 1891–93 he was one of the vice-presidents, and was elected to the presidency at the annual meeting last fall. He took a deep interest in the affairs of the Society, and always presided over its meetings with great dignity and attracted to himself the members by the charm of his manner and the clear comprehension of all matters brought to his attention. He was very quick of apprehension and prompt in deciding matters on which he was called upon to act. He would not be regarded as a person having an inventive turn of mind, but merely as one with much executive ability and capacity of selecting right things, right ways, and right times for doing what had to be done.

He left a wife and four children, who were in Richmond at the time of his death. The burial was at Pottsville, Pa., where the funeral was attended by many of his old friends, associates and employers, and by a number of members of the Society of which he was the honored president.

PROCEEDINGS OF SOCIETIES.

The Blacksmiths' Association.—The National Railroad Master Blacksmiths' Association, or the N. R. M. B. A., as it is designated, will hold its annual meeting in Cleveland, O., on September 3. In the call for the meeting the Secretary says :

"Our object is to acquaint each other with a multitude of valuable experiences wherein each assimilates from all. Emulation is stimulated, range of knowledge broadened, secretiveness and self-exaltation become abashed. To some people the chief purpose of the N. R. M. B. A. seems to be the reading and printing of papers. While this may be one of the features, and of the greatest good to non-attendants, it is but the focusing of all minds for mutual edification and instruction. The printed record is for reference only."

An International Institute of Engineers and Architects.—Elmer L. Corthell, C.E., of 71 Broadway, New York, late Chairman of the General Committee of the Engineering Congress, has issued a proposition for the organization of an International Institute of Engineers and Architects.

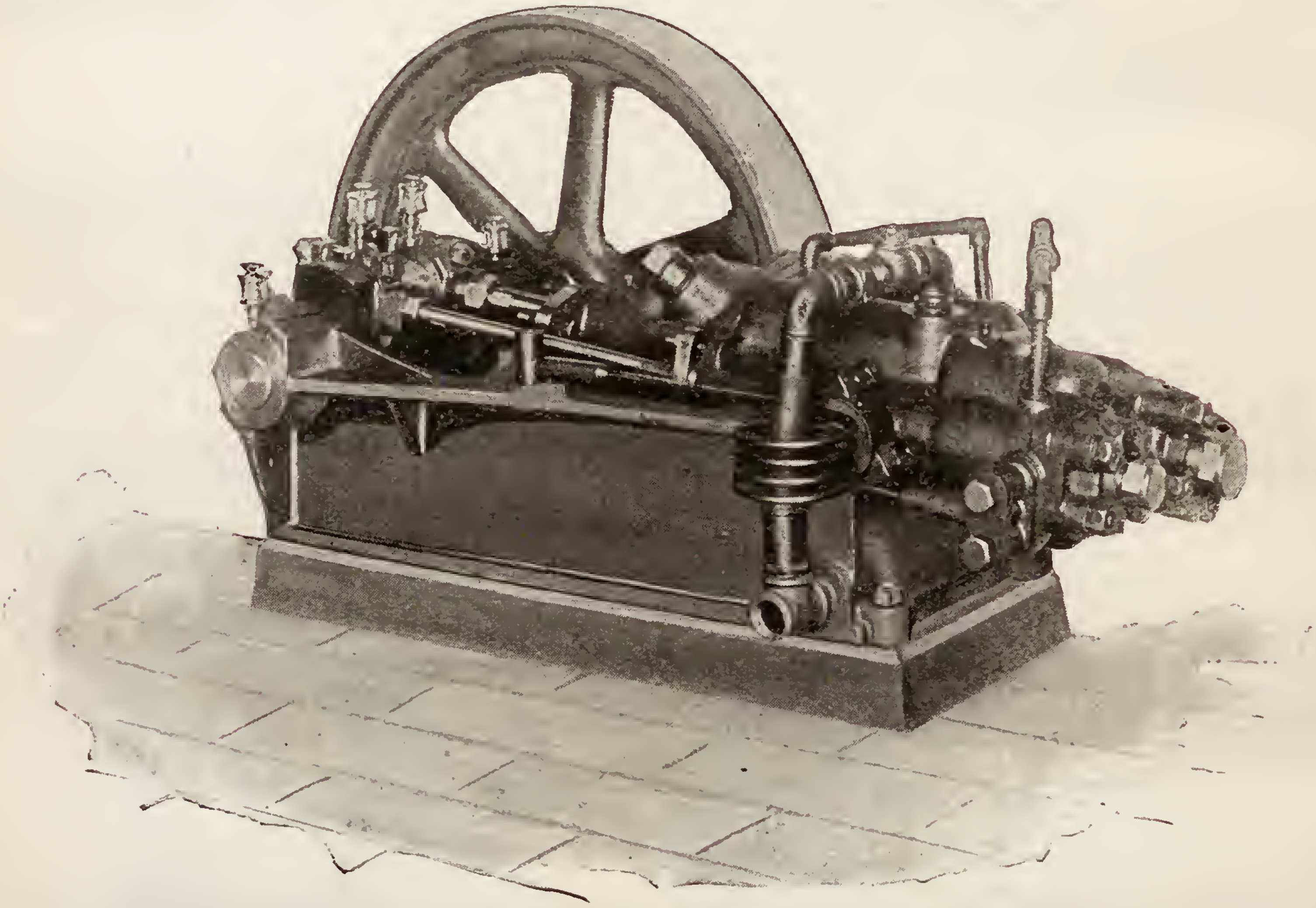
The principal objects of establishing this Institute are :

1. To unite in closer relations all departments of engineering and architecture.

2. To furnish a suitable and convenient channel by which information relating to new discoveries, processes, methods, inventions, and works may pass from one country to all other civilized countries of the world for the benefit of the profession and of mankind.

3. To conduct, by the assistance of the Fellows of the Institute, individuals, and governments, systematic and thorough tests of all classes of materials used in constructive work, and to disseminate through the channel of the Institute the resulting information.

An elaborate organization is proposed for the accomplishment of these objects, which is fully described in the circulars, copies of which will be furnished by Mr. Corthell on application.



THE NORWALK COMPRESSOR FOR HYDROGEN GAS.

Manufactures.

COMPRESSOR FOR HYDROGEN GAS.

We have published frequent notes and a full description of Captain Glassford's experiments with war balloons for the United States Government.

We have, however, never before been able to publish a photograph of the hydrogen gas compressor used to reduce the gas to the necessarily small volume required for transportation.

Heretofore in the countries which have given most attention to ballooning, the operations have been largely confined to captive balloons sent up from places where there were permanent means for producing gas. Armies on the march and in the field have been unable to carry the cumbersome and heavy apparatus necessary for generating the gas on the spot. Now, however, that steel tanks filled with hydrogen under pressure are available, there is no reason why the entire outfit necessary for operating a balloon should not be carried as a regular part of the baggage train, thereby introducing a new factor in the defensive if not the offensive plans of war.

This machine was built expressly for Captain Glassford's experiments by the Norwalk Iron Works Company, of South Norwalk, Conn., from whom we obtained the photograph.

This compressor, which is only 5 ft. long and 2 ft. high, compresses the gas in three stages and is capable of working continuously, storing hydrogen in steel cylinders at a pressure of 2,500 lbs. The reduction of bulk in the gas at that pressure allows each cubic foot to occupy $\frac{1}{175}$ of the space occupied at atmospheric pressure. In other words, a small cylinder containing 10 cub. ft. of gas at 2,500 lbs. pressure would fill 1,750 cub. ft. of balloon space.

The machine as shown can compress 10 cub. ft. of free gas per minute. The mechanism is very simple and not liable to get out of order.

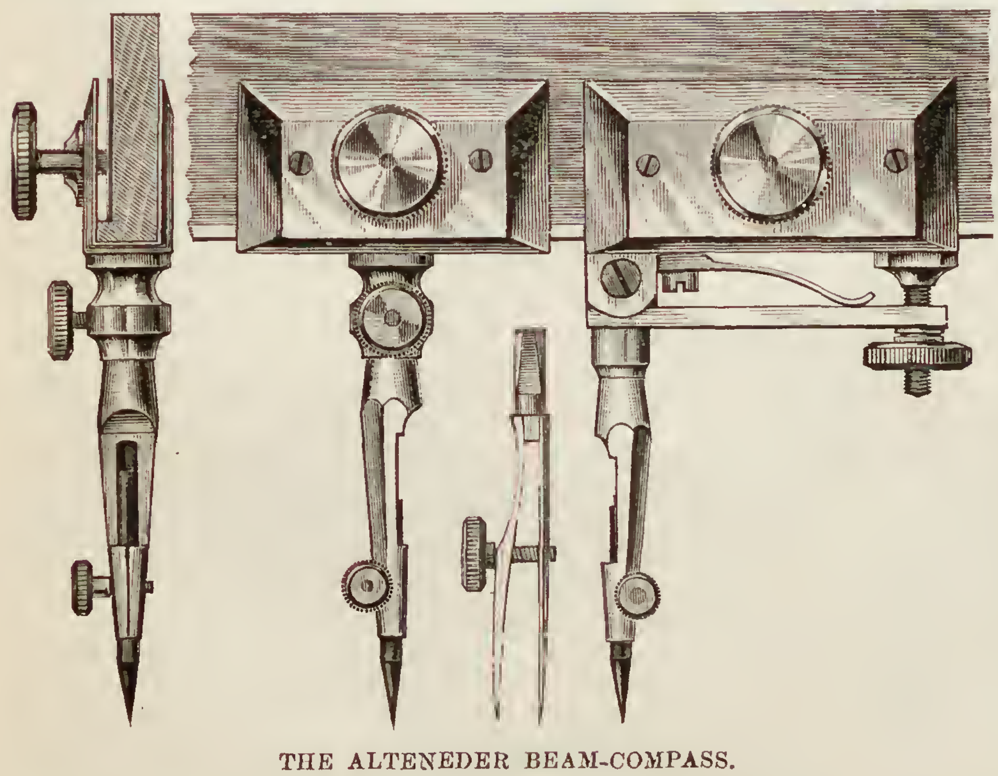
The gas is led into the larger cylinder shown at the front of the machine, through the larger flexible pipe shown at the right. It is then compressed to the space required by the second cylinder, the heat of compression being removed by the water jacket surrounding all three cylinders. The same operation is continued in the second and third cylinders and the gas discharged through the copper coil and connection shown in the engraving. By compressing in three stages, both excessive heat and excessive strains are avoided.

The machine is run by belt power, the pulley being only 32 in. in diameter. All three cylinders work upon the same trunnions, and the valves in all the cylinders are easily accessible. The hydrogen is compressed dry, thereby avoiding the additional weight which would arise from moisture in the gas and the danger of rotting the balloon by the presence of heat and moisture.

The Norwalk Iron Works Company also furnished the compressor used in firing the first dynamite gun, a pressure of 3,000 lbs. being guaranteed.

THE ALTENEDER BEAM-COMPASS.

A NOTICE of the catalogue of Messrs. Theodore Alteneder & Sons appeared in the last number of THE AMERICAN ENGINEER, which contained some criticism of the form of beam-compass which they make. It was said that "every time the screw is slackened which holds the sliding-head to the beam, the head becomes detached and must be held in position." This the Messrs. Alteneder say is not the case, and in evidence thereof have sent us one of the instruments of this kind which they make, and also a marked copy of their catalogue and an illustration of their instrument, which we publish herewith. From this it will be seen that their beam-compass consists of two sliding heads, the transverse sectional form of which is that of a letter U. In their catalogue it is said, "Each of these channels is provided with a light metal shoe, adjustable by means of a clamp-screw and guided by two steel screws. The shoe (as shown alongside of the letter *a* in the end view)



THE ALTENEDER BEAM-COMPASS.

does not reach to the bottom of the channel, but leaves space enough for a flange (also shown at *a*) on the lower edge of a hard-wood bar, used in connection with the beam-compass. It will thus be seen that the shoe, with its lower edge resting upon the flange, serves to hold the channel in position while it is slid along the bar, a turn of the clamp-screw firmly clamping it in any desired position. The wooden bars with flange are inexpensive, and add greatly to convenience in handling the instrument."

From a more careful reading of this description, and an inspection of the engraving and the sample of the instrument which they have sent us, we see that our criticism was unjust, and that in its design and manufacture they have amply provided for the difficulty we erroneously and somewhat hastily concluded existed. All that we can find to say in mitigation of our hasty writing is, that the feature pointed out in the description, which has been quoted, is shown more clearly in the engraving above than it is in that published in the Messrs. Alteneder's catalogue. The instrument they make we find, on examination, is a very convenient one, is well made, and without the objections which we erroneously attributed to it.

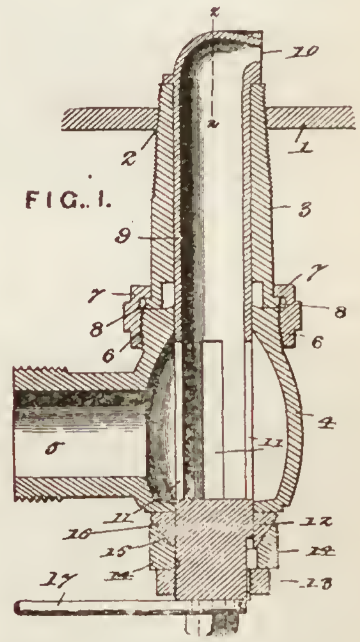
The objectionable binding of their catalogue the Messrs. Alteneder admit, and say will be obviated, but this is a matter of minor importance.

Recent Patents.

SMITH'S BOILER-CLEANING DEVICE.

MR. DIONYSIUS OLIVER SMITH, of Whistler, Ala., has patented the device represented by fig. 1 for cleaning locomotive or other boilers. It consists of what the inventor calls a cylindrical shell 3, which is screwed into the bottom of the shell of the boiler represented by 1. Inside of this shell is a rotatable tubular nozzle 9, which has a laterally deflecting discharge-nozzle 10, which is inside of the boiler. 5 is an inlet to which hose is connected and by which water is conveyed to the interior of the casing and by the openings 11 to the nozzle. 17 is a handle by which the nozzle can be turned, and as the stream of water is discharged from 10, it can be directed to different parts of the inside of the boiler. The nozzle is spirally twisted so as to distribute the water more generally.

This apparatus, we learn, has been applied to a number of locomotives on the Mobile & Ohio Railroad, and is giving great satisfaction. The patent is dated June 25, 1895, and is numbered 541,461.



SMITH'S BOILER-CLEANING DEVICE.

HOBART'S STEAM-ENGINE.

The inventor of the engine, of which a longitudinal section of the cylinder is shown by fig. 2, describes it as follows:

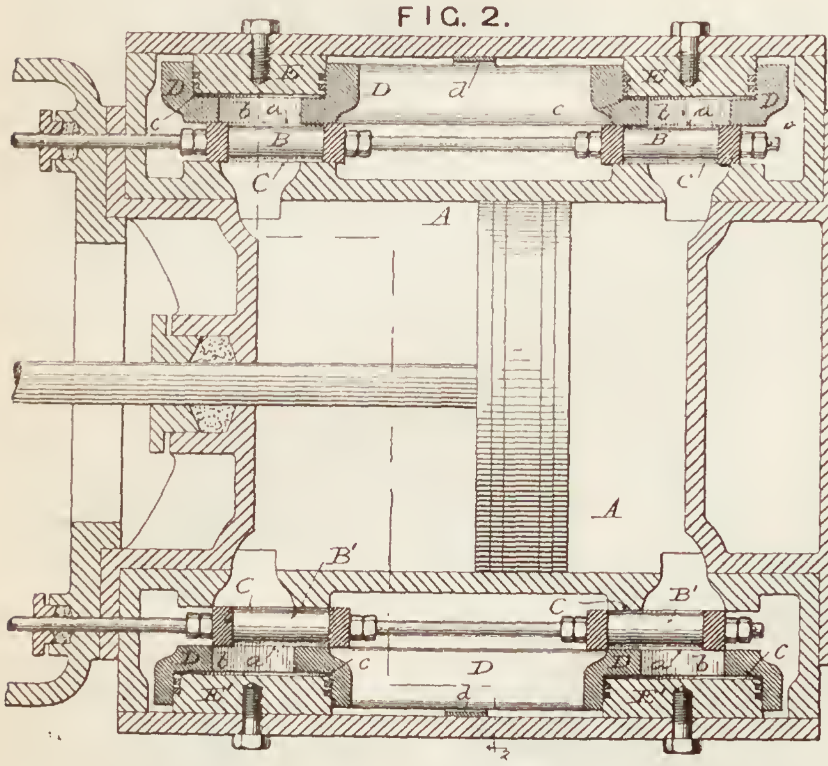
"The objects of the invention are, first, to produce an engine in which the valves shall be so nearly balanced as to be easily operated, and which shall still be held to their seats by enough unbalanced pressure to keep them always steam-tight; second, to produce an engine in which the valves shall be adapted for use as both steam and exhaust-valves interchangeably, the same patterns answering for both; third, to produce valves having four openings for inlet or outlet of steam, thus reducing the travel of the valve in this proportion; fourth, to produce a valve which may be easily adjusted to give the best possible distribution of steam under all circumstances; fifth, to produce an engine in which the valves will operate equally well at high and low speeds; and, sixth, to produce a simple practical construction well adapted to economical manufacture.

"*A* indicates the cylinder and *B B'* the valves, the latter working between the valve-seat *C* on one side and a corresponding seat on the relief plate *D* on the other side, thus giving four edges controlling the admission and exhaust of steam.

"The valve *B*, which is rectangular in outline with an open rectangular space, has long been in use, and is not claimed herein, the invention relating to the means employed for balancing it and to the application of such means to both admission and exhaust-valves.

"Relief plate D may be made, as in figs. 1, 2 and 3, of a single casting having two seats, one for each valve; or made as in the remaining figures, with each seat or end independent of the other. In all cases, however, it has on one face a seat or surface a in contact with the valve, and in said seat or surface an opening b having edges corresponding with the valve-seat on the cylinder. On the opposite face there is a larger opening c of any desired shape, but preferably cylindrical, to receive a piston E, which is fitted steam-tight in said opening by means of the usual packing-rings, or in any other suitable manner.

FIG. 2.



HOBART'S STEAM ENGINE.

"Piston E is supported from the back by attachment to the chest cover, or in other suitable manner. The space below the piston is open to or in communication with the open space within the valve, and thence with that end of the cylinder to which the valve is applied; the piston therefore acting to relieve the plate D from the steam pressure over its area, and by making it larger or smaller, a less or greater degree of pressure between the working surfaces can be secured. When used with an exhaust valve, B', the pressure within the cylinder usually exceeds that in the chest, and the piston E' should have an area a little in excess of the unbalanced area inclosed by the valve, the valve surfaces then being held in contact as before by a moderate force. Springs d d are inserted above the relief plate D, see figs. 1 and 2, and serve to keep the valve surfaces in contact when the valve is open and all of the parts are in equilibrium."

The inventor is Mr. Frank G. Hobart, of Beloit, Wis. His patent is No. 541,665, and is dated June 25, 1895.

NORDBERG'S FEED-WATER HEATER.

Fig. 3 is a vertical medial section of heater. Fig. 4 is a side elevation of the same, a section thereof being removed and a portion of the jacket or shell being broken away at its upper end. Fig. 5 is a vertical medial section of the base of the heater, taken in a plane at right angles to that of fig. 3. Its operation is as follows: Water entering the upper portion of lower chamber A through pipe F (shown in fig. 5) passes thence upwardly, as indicated by arrows, through the tubes C C and D into the upper chamber B, and, rising therein to the level of the upper end of pipe E, descends through said pipe and passes out of the heater through the branch E' to the boiler or other apparatus to be supplied. Steam entering the annular belt a' in the base through the inlet-opening a^2, therein expands and fills said belt on that side of the heater, transmitting a portion of its heat to the walls of chamber A, which in turn transmit it to the water contained therein. The steam being prevented by the partitions J J from passing around said belt a' to the outlet-opening a^3 on the opposite side of the heater, is compelled to rise in the space between the tubes C and shell H, and, passing upwardly and between said tubes, gives off its heat, which is transmitted through the walls of the tubes to the water contained therein. The partition-plates K K compel the steam as it rises above chamber A to pass upwardly and across the heater between the tubes C C and D before it can escape through the outlet-opening a^3, and thereby give off the greatest possible amount of heat which it contains to said tubes, to be transmitted thereby to the water passing through them. As the water enters the upper portion of chamber A the flow is checked, and any impurities contained therein are allowed to settle to the bottom, from which they may be readily removed through the hand-hole a^4. The water thus freed from a portion of the impurities contained therein passes from the upper portion of chamber A through tubes C C and D into the bottom of chamber B, where its flow is again retarded and remaining impurities are allowed to settle.

FIG. 4.

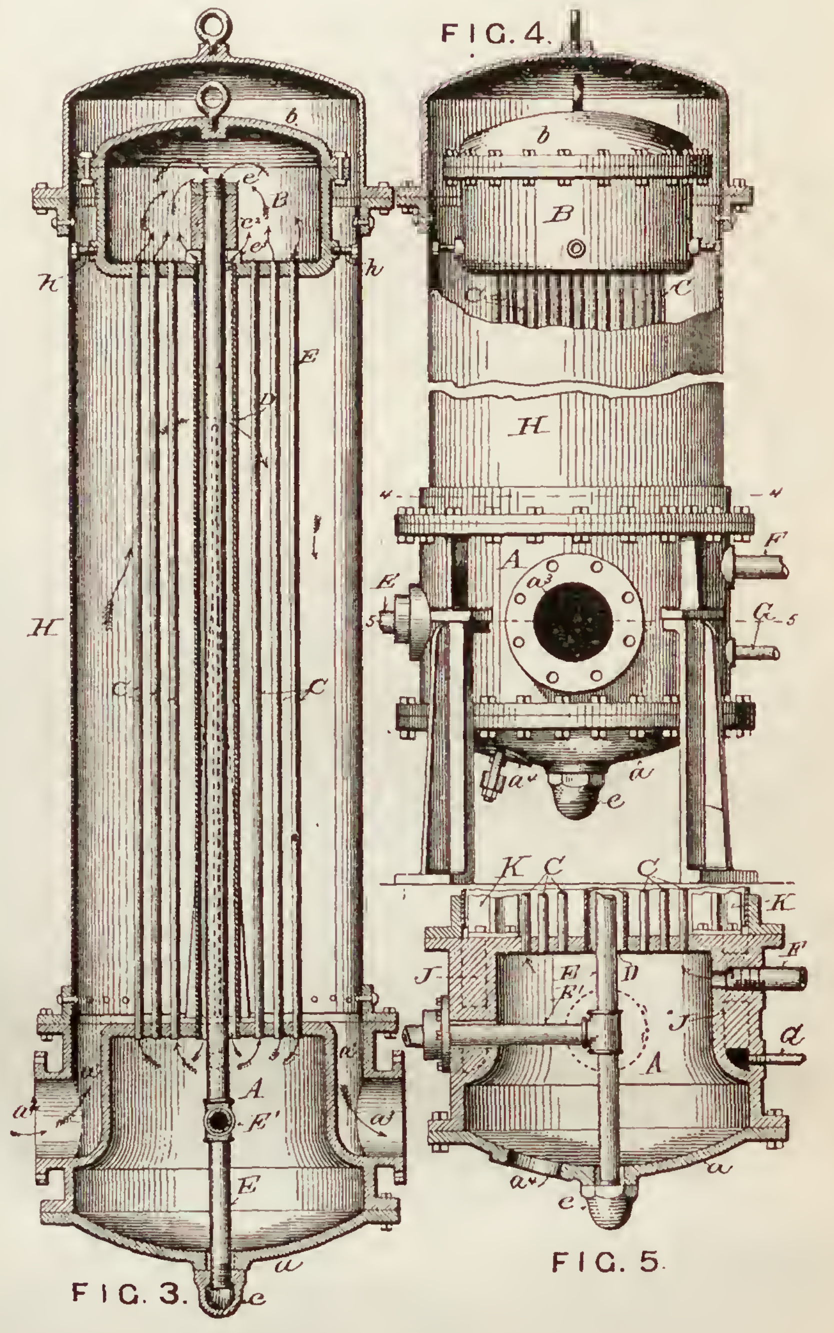


FIG. 3. FIG. 5.

NORDBERG'S FEED-WATER HEATER.

From the upper part of chamber B the purer clarified portion of the water which has been heated by its passage through the tubes C and D exposed to the steam is drawn off through the base by the return and outlet-pipe E E'. While water is passing through the upper and lower chambers and the tubes connecting them the jacket H may be removed without disturbing the exterior connections of the heater, and any leaks in the joints can thus be readily detected and remedied. For the purpose of inspection, repairs, and the removal of sediment, access is readily had to the interior of chambers A and B and to the open ends of tubes C C and D by removing the bottom a of the lower head and the cover b of the upper head. To remove the bottom a it is only necessary to unscrew the nut e on the lower end of pipe E, and take out the bolts by which the bottom is secured to the base. To remove the cover b it is necessary to first remove the shell H, and then the bolts by which said cover is attached to the upper head, but in neither case are the steam and water inlet and outlet connections with the base disturbed.

The inventor is Bruno V. Nordberg, of Milwaukee, Wis. His patent is dated July 2, 1895, and is numbered 542,004.

AERONAUTICS.

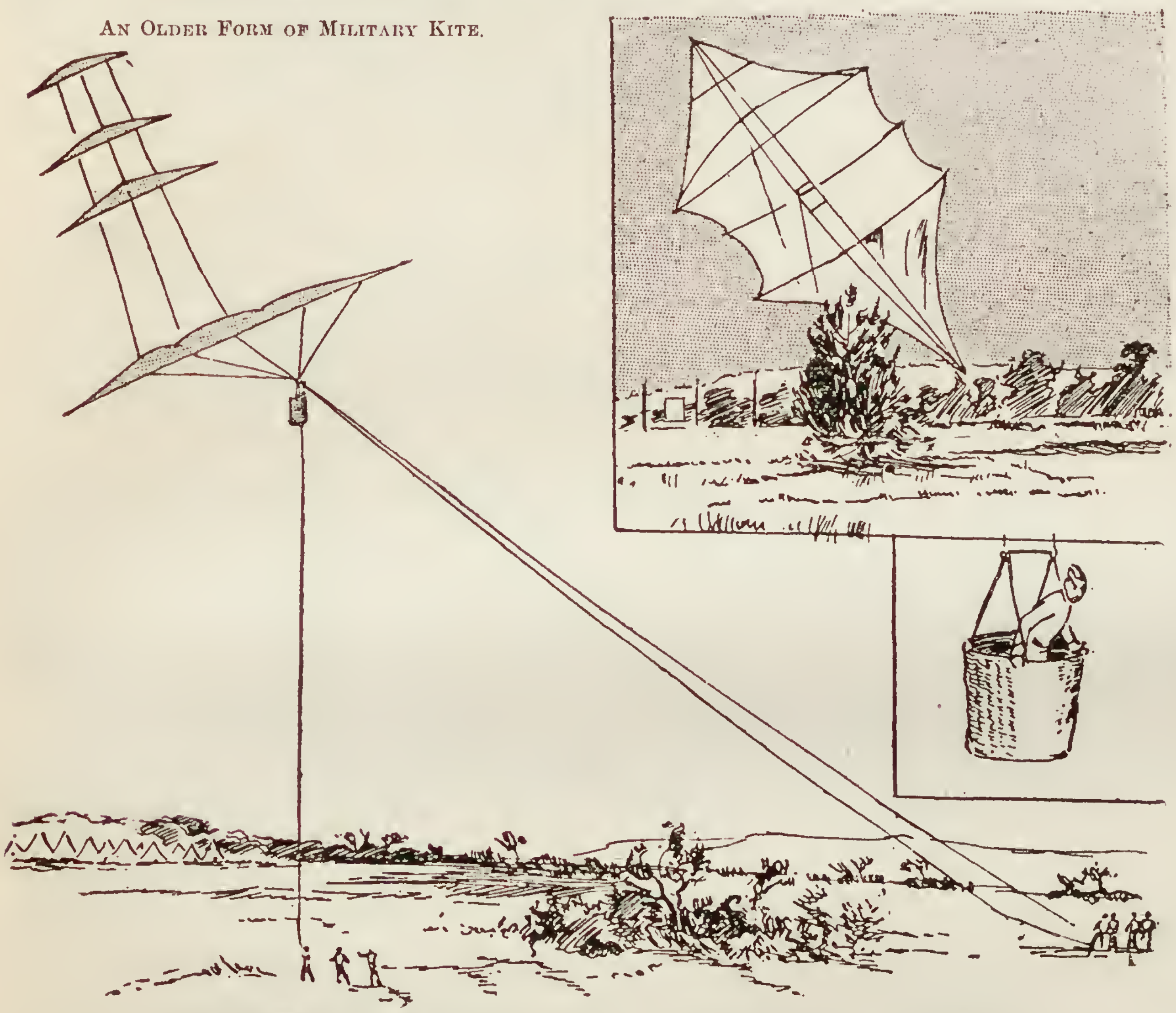
UNDER this heading we shall hereafter publish all matter relating to the interesting subject of Aerial Navigation, a branch of engineering which is rapidly increasing in general interest. Mr. O. Chanute, C.E., of Chicago, has consented to act as Associate Editor for this department, and will be a frequent contributor to it.

Readers of this department are requested to send the names and addresses of persons interested in the subject of Aeronautics to the publisher of THE AMERICAN ENGINEER.

THE WAR KITE.

EXPERIMENTS have been carried on for some time past at Pirbright with a new aerial apparatus to be used in the place of a captive balloon for military purposes. It is the invention of Lieutenant Baden-Powell, of the Scots Guards, and consists chiefly of a huge kite containing some 500 sq. ft. of canvas, which is assisted and steadied by other smaller kites. Not only has it been found, writes a military correspondent, that this apparatus can lift a man in moderate breezes, but it has lately been proved capable of doing so in a dead calm, the ropes being drawn along by men or by horses. The inventor delivered a lecture on the subject at the Royal United Service Institution on May 22, 1895.—*The Daily Graphic.*

AN OLDER FORM OF MILITARY KITE.



EXPERIMENTING WITH LIEUTENANT BADEN-POWELL'S APPARATUS.

ELASTICITY OF THE WING.

IT is well known that mathematicians have thus far been unable to compute satisfactorily the air reactions which take place under a bird's wing, more particularly in beating flight. They have made many calculations, but these did not agree with the facts. By figuring out the pressures generated on a plane (assumed to be the wing surface), at the known average speed of the down-beat of the wings, it was found that this calculated pressure was not equal to the weight of the bird.

Thus Mr. Drzewcicki showed, in his paper upon bird flight, read before the Paris International Congress in 1889, that a buzzard in full horizontal flight, weighing about 4 lbs., and with an aggregate wing surface of 2.15 sq. ft., would only generate, when beating his wings downward at an observed velocity of 6.56 ft. per second at the assumed centre of pressure, a sustaining air reaction of 0.40 lbs., which was of course quite insufficient to sustain the weight. Mr. Drzewcicki explained that the error in this case lay in neglecting the sustaining aeroplane reaction due to the forward speed, but the fact remains that calculations made for plane surfaces do not agree with the observed phenomena of bird flight.

A great many hypotheses have been advanced to account for this mystery. It has been suggested that the bird possesses some undiscovered skill, to increase the effect of his wing beats, by some "whip-lash" action at the end of the stroke, or to evade air resistance on the up-stroke by valvular action of the feathers The writers advancing these theories have generally seized upon some one ascertained fact, and sought to account thereby for the full mystery of flight.

Lilienthal, however, showed by experiments on models, and by subsequent practice in the field, that sustaining reactions were fully accounted for by the arched surface of the wing, and that much higher coefficients should be applied to air pressures corresponding to given velocities than is the case with planes. For beating flight, however, his data and premises are thought to be incomplete, and a number of papers have lately been published in Germany charging him with having neglected to consider some of the elements of final success.

Two of the latest among these papers refer to the elasticity of the wing and of the feather. They were written by Dr. George Berthenson, a Russian military surgeon, and by Captain H. W. L. Moedebeck, of the German artillery, and in charge of military ballooning.

Dr. Berthenson's paper was published in *Gegenwart*, January 26, 1895. It criticises Lilienthal's apparatus as imperfect, because its arched surfaces are unvarying in curvature, and do not change their shape in flight; refers to theories on this point previously advanced by C. Buttenstedt and by W. Berdrow, in books published in 1893 and 1894, and makes the broad claim that the propelling action of beating wings depends entirely upon their elasticity, no propelling effect being deemed possible with a wing absolutely rigid and fixed in outline.

The attempted demonstration of this dictum is rather hard to follow, because the author introduces considerations of what he terms "reserved curvature," bringing into play "reserved elasticity," and finally says that "the main requisite toward solving the flying problem is to determine the quantitative relations between the active force of man, the passive elastic force of the structure, and the work of gravity. This ratio is: Gravity, 1; elasticity, 2; muscular effort, 3."

Whatever this may mean, the practical application to Lilienthal's apparatus is contained in the two following extracts:

"Lilienthal says that birds' wings are arched, but he has not stated that this curving is elastic, and therefore not constant, so that under a certain combined action of gravity and of the muscular force of the bird, the curvature gradually vanishes. Buttenstedt demonstrates this, and shows that when the entire force of the bird is exerted the wing approximates to a plane surface. . . ."

"Lilienthal now intends to build beating wings of 14 sq. metres (150 sq. ft.) in area, because he now believes that wings

that merely soar do not possess propelling power. This will make his apparatus unnatural and unfit for use. Just as his placing high of the centre of gravity is dangerous and contrary to nature."

Captain Moedebeck's paper was published in the *Zeitschrift für Luftschiffahrt und Physic der Atmosphere* for May, 1895. It reviews Dr. Berthenson's paper, gives him a rap over the knuckles for the obscurity of his explanation, and propounds the inquiry as to what is the real use of the known elasticity of the wing and of the feathers.

This, as Captain Moedebeck believes, has a threefold object:

"1. To save strains on the muscles and the skeleton of the bird by gradually distributing the resistance of the air, produced by the wing through the muscular efforts of the creature.

"2. To produce horizontal propulsion, both in wing beating and in soaring.

"3. To prevent whirls and eddies in the escaping air, and the resulting friction, and to ensure the stability of the flight."

As to the first object, the author says:

"It is easy to convince one's self by mere sense of touch of the correctness of the above statement, by alternately wafting up and down through the air a large primary bird feather, and an artificial feather of the same shape, but stiff and unyielding. The bird feather, through its elasticity, adapts itself, so to speak, to the resisting air, and the pressure is conveyed in a gentle and stable manner. On the contrary, with the stiff artificial feather, one feels very irregular and uncertain pressures. The resistance of the air tries to break the surface, which does not adapt itself to the strain."

In other words, as the author justly remarks, the elasticity of the wing acts, in this respect, as does a spring in a terrestrial vehicle.

As to the second, or propulsive effect, the author explains that this is chiefly obtained through the primary or rowing feathers, which are bent at their outer ends by the air pressure, so as to present inclined planes behind the line of flight, and he says:

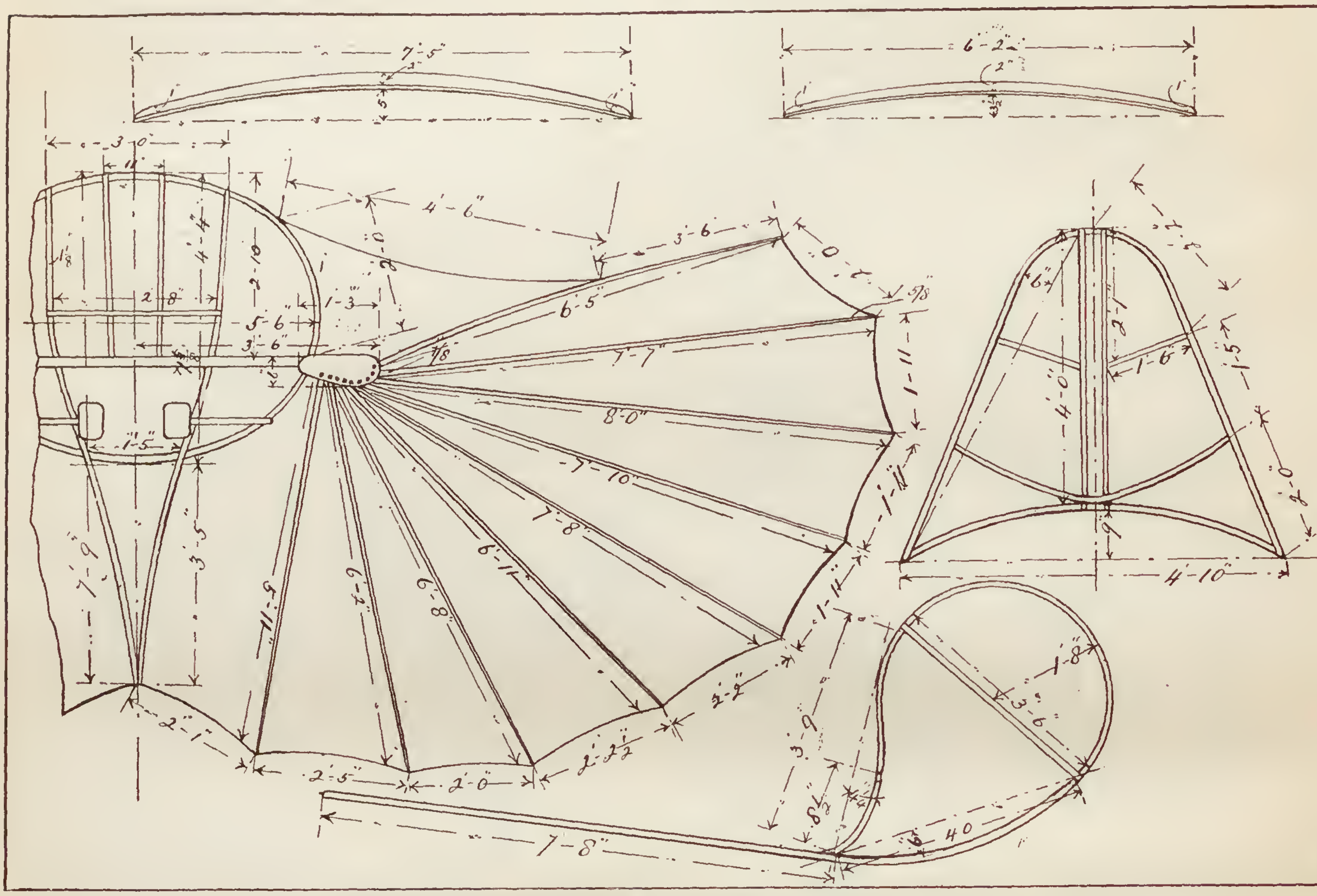
"The pressure of the air generated by these feathers can therefore be decomposed into two components, one horizontal and propelling forward, and the other vertical and sustaining the weight. The great length of lever-arms of these feathers produces a considerable effect, notwithstanding their small breadth."

In other words, the air escaping to the rear turns up the ends of the feathers, and presses against this as an abatement to drive the bird forward.

As to the third effect, or the prevention of eddies which might compromise the stability, the author says:

"Eddies are produced when separate layers of a fluid or gaseous medium suddenly come together. On the down-beat of the wing there is rarefaction above and compression below. The air endeavors to equalize its pressures; the denser air, escaping upward from a rigid wing, would produce whirls and eddies along its edges. If these were quite the same at all the edges, front and rear, there would be equilibrium. It is a condition, however, for all flying bodies that they shall be in unstable equilibrium. Absolutely rigid bodies, therefore, with an irregular escape of air, would be kept oscillating slightly, a fact which would make their use dangerous and difficult. The long primary feathers, however, have their points turned somewhat upward on the down-beat, and thus the pressure is able to escape continuously in spiral paths. This uniform escape of the air along the wing must essentially aid stability in flight. The elasticity of the feather thus facilitates a gradual passage of the air into its former condition, and the forces which would otherwise produce dangerous eddies are utilized in the interest of stability."

In other words, the elasticity of the feathers produces a more uniform escape of the compressed air, and so avoids unbalanced strains, which might compromise the equilibrium.



WORKING DIMENSIONS OF A LILIENTHAL FLYING MACHINE.

A LILIENTHAL FLYING MACHINE.

The two half-tone illustrations herewith are front and back views of a soaring machine built by Herr Lilienthal for parties in England. The outline engraving is from a drawing, and shows views of the same machine and gives dimensions of its principal parts. The following particulars of its material and mode of construction will be interesting to many of our aeronautical readers:

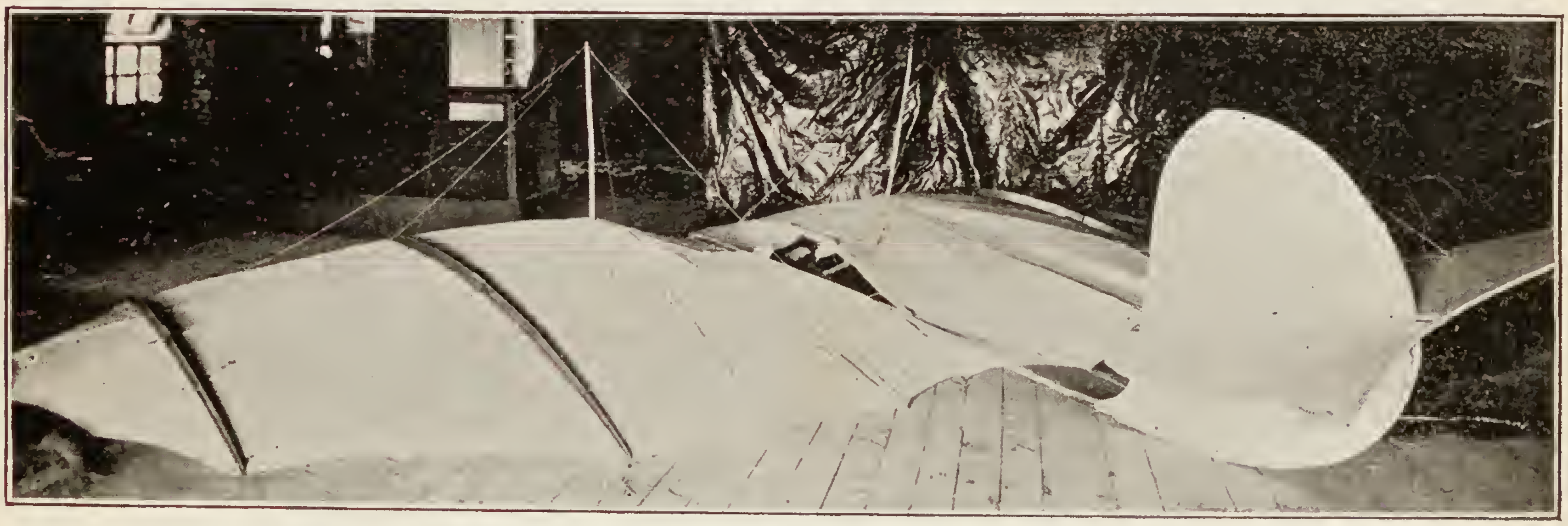
Surface of main wings	252 sq. ft.
" " horizontal rudder	12½ sq. ft.
" " vertical rudder	10½ sq. ft.

WEIGHT OF MACHINE.

Body	48 lbs.
Horizontal rudder	2½ lbs.
Vertical rudder	3½ lbs.
Total	54 lbs.

The framework is made of willow rods of about 1 in. in diameter with the bark peeled off. This is covered with calico sheeting, dressed, it is said, with an india rubber and naphtha solution to prevent wet from affecting it.

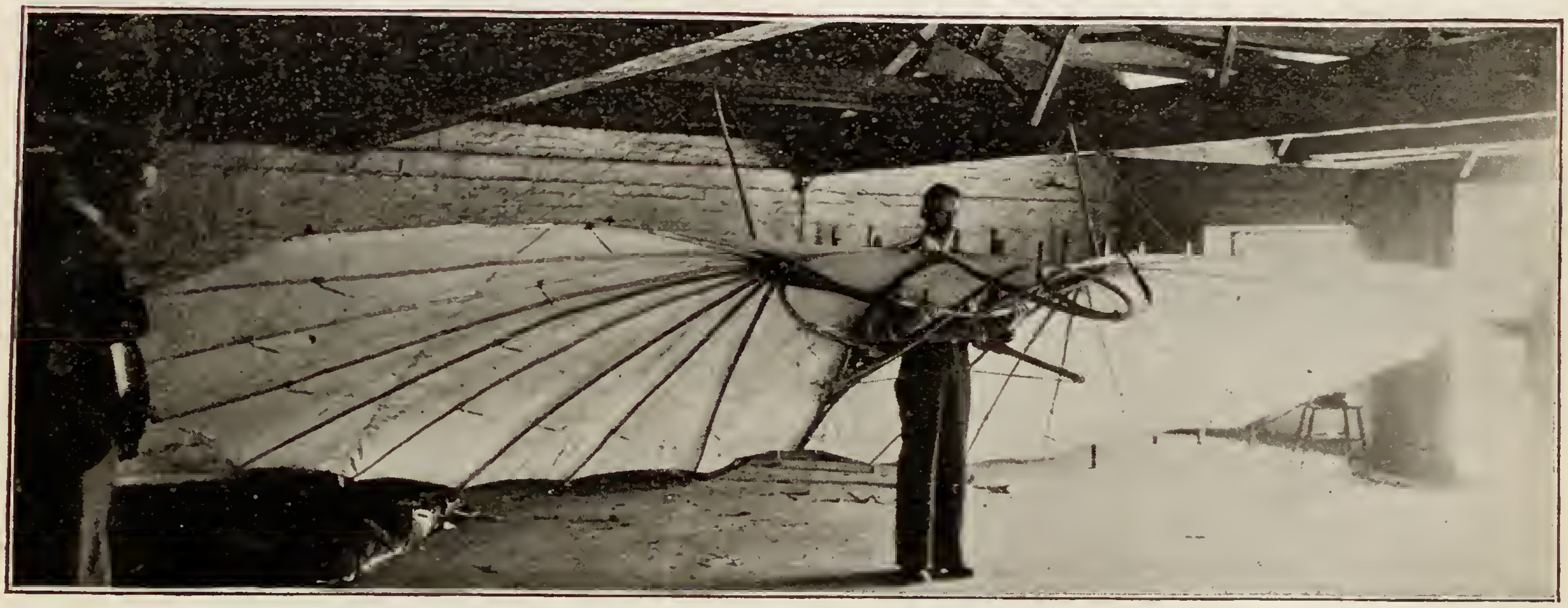
The main frame is made of willow wood, similar to that used for cricket bats, also the curved T pieces, which give the wings the hollow spoon shape. The wire stays are of galvanized steel 20 Birmingham wire gauge, with small screw lanyards for making all taut.



TOP VIEW OF A LILIENTHAL FLYING MACHINE.

The horizontal rudder is put at an angle of 10° with the horizon. In using the machine, the arms of the operator or aeronaut are passed through leather armlets, the hands grasping the cross-bar in front. Pads on the machine grip under the shoulders to help to support the weight of the body.

The note which we publish herewith announces that Mr. Lilienthal has discovered a method of controlling his machine which permits an operator with comparatively little skill to achieve flight. If this discovery fulfils its promise, we may not unreasonably expect in the not very distant future that soaring machines may be generally used as vehicles for diversion somewhat as bicycles are now.



A LILIENTHAL FLYING MACHINE SEEN FROM THE FRONT.

It is understood that Herr Lilienthal has lately added a contrivance to his apparatus which increases its stability to such an extent that any unskilled person can easily learn its use. It is expected that this improvement will make air sailing a popular sport, and make the manufacture of such machines commercially profitable.

EXPERIMENTS ON WIND PRESSURE.*

THE subject of wind pressure is one on which our knowledge at the present day is not only limited, but exceedingly vague, and carefully made experiments, if but to investigate a single feature of the problem, are, therefore, of the greatest interest, and can hardly fail to add something new to our information. Mr. J. Irminger, C.E., Member of the Danish Society of Engineers, has determined, what it is believed no one before him has attempted to do, the amount of suction produced by a current of air striking a plane surface, or the surfaces of various bodies; and the results of his experiments form the subject of a paper with the above title, read before that Society in the early part of last summer. These results are remarkable in showing how very large a percentage of the total effect this suction is, not only through its action on the leeward side, but on the windward as well. In fact, when the angle at which the wind strikes a plane surface is small, nothing but suction is produced.

The practical importance of these experiments is evident; they throw considerable light on the subject of flight, which at present is engaging so much attention; and in structural designing they point out the way to more rational methods. We have hitherto considered the resultant of the pressure only, but if that of the suction is also taken into account, the final resultant is changed both in amount and direction. Thus in the case of a roof, given below, the resultant of suction and pressure will tend to lift, and not overturn it, which is in accordance with experience.

Experiments on wind pressure have usually been made by causing the body subject to the pressure to revolve in still air. The author's experiments were made with a fixed body

* Reprinted from the Proceedings of the United States Naval Institute.

exposed to a current of air. This current was obtained by making an opening into a large chimney 100 ft. in height and fitting to this opening a rectangular, horizontal wooden tube, 9 in. × 4½ in. in section, internally polished. The experiments were directed to ascertain the distribution of pressure over the surfaces both of planes (*i.e.*, solids of small thickness) and of bodies of various forms. Taking first the case of planes, the plane was represented in the experiments by two pieces of sheet iron, 4½ in. × 1½ in., placed $\frac{1}{10}$ in. apart, and connected together along their edges so as to form a shallow closed box. To the interior of this box a pressure gauge was connected by means of a small pipe. A number of small holes were made in both faces of the box, of which one at a time was opened. By this means the pressure gauge registered the pressure at any desired point in the windward or leeward side of the box. The pressure-pipe formed an axle on which the box could be turned to any desired angle with the wind. By means of a valve in the wooden tube the velocity could be varied. The velocities employed were from 25 ft. to 50 ft. per second. Besides the plane above described, which occupied the full width of the tube (and may therefore be considered to represent in the open air a plane whose width is very great in proportion to its length measured in the direction of the wind), another plane was experimented with, measuring only 2½ in. × 1½ in. It should be remarked that the velocity of the wind was obtained from the observed normal pressures by reference to the ordinary tables. In the following tables, based on the experiments, it should be especially noted that at small angles of incidence the effect of rarefaction on the leeward side (showing itself as suction) causes practically all the pressure on the plane, and that at so small an angle as 5° this suction is over one-fifth of the total pressure (that caused by the wind direct, plus that caused by suction) on the same plane placed normally.

PLANE 4½ IN. BY 1½ IN. (FULL WIDTH OF TUBE.)

Angle of inclination of plane to direction of wind.	Proportion per cent. of total pressure produced on leeward side of plane, velocities of wind in feet per second being				Proportion per cent. of total wind pressure to pressure on same placed normally (average).
	49.5	48.5	34	31	
5°	100	100	100	100	23
10°	82	83	90	91	45
20°	76	81	89	86	48
40°	65	67	68	70	75
60°	60	63	65	63	90
90°	56	58	56	59	100

PLANE 2½ IN. BY 1½ IN.

5°	100	100	100	100	12
10°	100	100	100	100	26
20°	95	99	91	90	52
40°	78	76	70	74	74
60°	60	55	55	56	90
90°	48	43	44	46	100

The total pressures agree fairly well with those of Professor Langley, given in the Proceedings of the Royal Society for 1889. The variations are readily accounted for by the change in form, which has considerable effect, even with plane surfaces.

Doubtless in connection with the observed results at small angles of incidence, many readers will call to mind cases where, with a light beam wind and yards nearly square, a vessel under sail alone has made some phenomenal speed, unaccounted for except on the supposition that the real direction of the wind was from a point abaft its apparent direction. This, however, is no explanation at all, as will be seen by a little consideration. What is meant by the real direction of the wind is only relative; it is the direction with regard to a fixed point on the earth's surface. The apparent direction of the wind is a resultant of two motions, and is the true direction with regard to a moving object on the earth's surface—namely, the ship. There is no more reason to take into consideration the direction of the wind with regard to a fixed point on the earth's surface, than with regard to a fixed point in space, and this latter is manifestly absurd. But much of the result of trimming yards fine for winds abeam is readily accounted for by the suction.

Probably the high speed of the ice-boat is largely due to the same thing. The same is true of windmills.

It is observed that the bird holds its wing at an angle of 6° with the horizon; at this inclination the effect of the wind upon the under side of the surface is zero, while the suction acting in the upper side is equivalent to an upward pressure which sustains the bird. Moreover, the friction of the medium through which the bird moves is hereby reduced, and a current is produced acting toward the wing, and inclined upward at a small angle.

The following table gives the results of experiments on long prisms, placed with their axes at right angles to the wind. p is the total pressure on a long plane of width s placed normally to the wind, and of the same length as the prism. It has been shown that about 57 per cent. of p is due to rarefaction, causing suction on the lee side:

CROSS-SECTION OF PRISM.	Total Resultant Pressure in Direction of Wind.	Percentage Due to Rarefaction.
Square of side s (wind parallel to side).	0.95 p	43
" " " s " " "diagonal	0.79 p	76
Circle of diameter s............	0.57 p	72
Rhombus, presenting an angle of 60° to the wind, length of side s.... ...	0.25 p	82
Equilateral triangle, side s (wind parallel to side)............	0.59 p	42
Equilateral triangle, side s (presenting apex to wind)............	0.42 p	86
Equilateral triangle, side s (presenting base to wind)............	0.71 p	87

The following table refers to other than prismatic forms:

BODY UNDER EXPERIMENT.	Total Resultant Pressure in Direction of Wind.	Percentage due to Rarefaction.
Sphere............	0.31 of total pressure on disk equal to great circle............	77
Sphere distorted by elongation in the direction of the wind to double the diameter in length, ends pointed and symmetrical.........	0.08 of total pressure on disk equal to cross-section....	93
Cube of side s (wind parallel to edge)............	0.80 of total pressure on disk, equal to face....	22
Cube of side s (wind parallel to diagonal of face)............	0 66 of total pressure on disk, equal to face....	55
Cylinder of height equal to diameter (wind perpendicular to axis).	0.47 of total pressure on square disk, equal to section through axis..	50
Pyramid, square base of side h, height h (wind parallel to side of base)............	0.78 of total pressure on disk, equal to maximum section perpendicular to wind......	37
Pyramid, square base of side h, height h (wind parallel to diagonal of base)............	0.55 of total pressure on disk equal to maximum section perpendicular to wind	55
Cone, height = diameter of base = h (wind parallel to base)..........	0.38 of total pressure on disk, equal to maximum section perpendicular to wind.......	50

The method used with these bodies is similar to that described for plane surfaces; the different bodies are hollow and made of thin sheet iron; they are about 4½ in. long, and provided with three holes in a row in the middle of one side. A hollow axis passes through the centre, and communication is made with the pressure gauge in the same manner as before.

In the case of the cylinder, which was examined by boring a single hole in it and revolving it gradually through 360°, it was found that pressure existed only between 0° and 35°, when the effect became a suction. Similar results were found for the sphere.

Models were also experimented with representing buildings with roofs of various forms, and diagrams are given showing the distribution of pressure over leeward and windward sides. In all cases rarefaction on the side is quite as important a factor in the actual resultant force on the building as is the positive pressure on the windward side. The case of the pitched roof making angles of 45° with the horizontal on which a horizontal wind acts at right angles to the ridge is particularly worthy of note, and furnishes some food for thought. The normal pressure on the lee side due to suction is more than three times as great as that on the weather side. The resultant pressure on the two faces (neglecting the walls of the building) is inclined upward, and is about three and one-half times as great as that on the weather side. On the weather side the pressure is greatest near the lower edge, diminishes uniformly, and becomes a suction near the ridge.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

Formerly the RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

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NEW YORK, OCTOBER, 1895.

ANNOUNCEMENT.

AFTER November 1 the AMERICAN ENGINEER will be published bi-weekly, and will appear every alternate Thursday. Each number will contain one-half as much reading matter as is now given in the monthly issue. The price, per number, will be reduced to 10 cents, and the annual subscription to subscribers in this country, Canada and Mexico to $2.50. Owing to the additional postage the rate to foreign subscribers will remain $3.50. Some changes, which it is hoped will be improvements, in the scope and character of the paper will be made, and will be announced later. It is also thought that the more frequent publication will enable us to keep more closely in touch with current events and the advancement of engineering art and science, and that the change will materially increase the interest of the paper to our readers and its value to our advertisers.

EDITORIAL NOTES.

HAVING carried on extensive experiments with armor-piercing shot, and learned the ratios existing between the penetrating properties of the shot and the resisting properties of the armor, the authorities at Indian Head are extending their investigations still further, and are now searching for the probable results to the framing of the ship should a shot penetrate to the interior. The first experiments are said to have proven that the framing is up to all of the requirements that can be expected of it, in that it will probably not be entirely annihilated by a penetrating shot. Still it is difficult to conceive how it would be possible for a 13-in. shell, for example, to enter the confined limits of the interior of a turret and not carry such devastation with it that the guns and men would be practically swept out of existence. This position seems to be corroborated by the reports that have reached us of the conditions existing on board the Chinese vessels during the Yaloo fight, where the crew seem to have been almost crippled by the heat, noise, and concussion, to say nothing of the entering shot. Still it is to be hoped that the Indian Head experiments will be carried to such a point that we may know just what to expect from the impingement on or penetration through a turret armor by a heavy shot.

IT is somewhat amusing to note the excitement, either actual or assumed, that the Baldwin-Westinghouse coalition announced in our last issue has created. It has been heralded as the knell of the locomotive and the victorious triumph of the electric motor ; whereas it is a straight business arrangement wherein two great establishments agree to work together for a mutual advantage. The death of the locomotive and the survival of the electric motor in its place is not expected in the immediate future by those who are leaders in the construction or development of either. Each has a field of its own that the other cannot fill. For years locomotives were advertised as suitable for and as especially adapted to street railway work ; yet we do not know of a single line through a city street that was operated by them, despite all the pushing that they received, though there were a few lines on the outskirts that were so operated. Yet within the short space of eight years the electric motor has swept the locomotive from every claim to suitability for this work. It has its place that the locomotive cannot fill, but until the conditions of efficiency, operation, and traffic are vastly different from those now prevailing, no electrician of repute will consider that the knell of the locomotive has been sounded.

MONTHLY MEETINGS OF MECHANICAL ENGINEERS.

INQUIRIES are beginning to be made whether those members of the Society of Mechanical Engineers who have an inclination to meet together, in New York, once a month, for the discussion of subjects in which they are all interested, are to have that privilege during the coming winter. As is well known, there has been opposition from certain quarters to the holding of such meetings, on the ground that they would be the cause of dissatisfaction among the non-resident members who cannot have a part in them, and the opponents would not consent to the holding of such conferences, as meetings of the Society, and therefore they have always been designated as meetings of *members* of the Society—which reminds us of a little story. During the war a sentimental young woman visited one of the army hospitals, and seeing a good-looking soldier among the sick, inquired of him whether she should bathe his fevered brow. "You may," he replied, "if it will do you any good, but you will be the fifteenth woman who has done it to-day."

Now if it does the opponents of these monthly meetings any good to call them meetings of *members* instead of meetings of the Society, the concession will be harmless, and it may be a comfort in some way to them. As a matter of fact, the objection which has been made is a purely imaginary one, and seems to exist, not among the non-residents, but only in the minds of a few New York resident members who prefer social to technical meetings and ice-cream to engineering. To all intents and purposes the meetings have been meetings of the Society, and therefore they ought to be conducted by the Council, either directly or through a committee. During the two years

that they have been held they have been very successful, and it is certain that if they are not continued it will be a cause of regret to many members to whom they have been a source of edification and enjoyment. It is moved that they be continued during the coming autumn, winter, and spring. Who will second the motion ?

RAILLERY.

Since the last number of the American Engineer went to press the technical and the daily papers in this country and in Europe have given much space to accounts and comments on the railroad contest in England and Scotland. It is hardly worth while now to attempt to give detailed accounts of this race, as it has been called. All that we need to say is that there are two lines from London, leading northward into Scotland, the terminus of both being Aberdeen. The general location of these being somewhat like that of two brackets placed thus (), the one on the right touches the east coast of the island, and the other the west coast. The distance from London to Aberdeen, by the East Coast line, is 523½ miles, and by the West Coast, 539¾ miles. These lines compete for business, and as a result of this competition the companies interested attempted to show which of them could run their trains in the shortest time. That it is not easy at this distance to know exactly what the results of this trial of speed were, is indicated by the remarks of a correspondent of the London *Engineer*, who has written an interesting account of the "race," and who says that "it may be observed that there is the greatest difficulty in obtaining trustworthy records of the actual times of the trains. It was obviously impossible for one man to go by all trains of both routes, and so recourse must be had to official records or passengers' timing. Unfortunately these disagree among themselves in many important subjects."

As nearly as we can make out from the published reports received at the present date, the quickest time made on the East Coast was 523½ miles in 520 minutes, including stops, or an average of 60.44 miles per hour. On the West Coast the run of 539¾ miles was made in 518 minutes, including stops, or 62.52 miles per hour.

Commenting on this, *The Engineer* says—and hence the title of our article : "One gratifying result of the race will be *perhaps** to silence the boasting of the American press. The far-famed Empire State Express has been thoroughly beaten. No engineer in this country, and probably very few in the United States, believes that a mile was once run on the New York Central in 32 seconds, or that 5 miles have been run in three minutes. Concerning long-distance runs, however, there is not room for doubt, an inaccuracy of a few seconds in timing being of no importance. It is said that the 'record run'† of the United States was from New York to East Buffalo, 439.5 miles, in 425 minutes, or say, 61.56 miles an hour. A reference to Mr. Rous Marten's article (published in *The Engineer*) will suffice to show that this has been most thoroughly beaten. We have, of course, yet to hear what United States railway men have to say concerning the race. Their comments can scarcely fail to be interesting."

The comment which is most "interesting" is not that of the newspapers, but of the trial made on the New York Central road on September 11, news of which will, of course, have reached our readers before this will. In this run the distance taken was 436½ miles, which was made in 411⅗ minutes, including stops, or at an average speed of 63.62 miles per hour. There has been some dispute about this also. The weight of the cars hauled on the New York Central road was nearly four times as heavy as that of those on the English trains. On the other hand, the grades on the English lines are considerably heavier. It is also said—which is true—that a helping engine was used in going up the heavy grade from Albany to West Albany, a distance of about 3 miles, and that the time of arrival at East Buffalo was taken without stopping. If the train had been slowed down before reaching East Buffalo, and brought to a dead stop, of course some time would have been consumed thereby. On the other hand, owing to the frequent grade crossings, on the New York Central line, there are many more places where speed must be slackened than there are on the English roads, where such impediments are much less common.

In view of the performance on the New York Central road, it may now be expected that the comments of *The Engineer* "can scarcely fail to be interesting."

* The italics are ours.

† This refers to a run made before that of September 11.

MATHEMATICAL PAPERS.

In reviewing the last volume of the Transactions of the American Institute of Electrical Engineers, the London *Engineer* says : "A few years ago the United States would have been the last place in which to seek elaborate mathematical theorizing about and all around engineering problems. It is, indeed, doubtful if anybody does seek it ; it seems to bubble out in some places, a pretty, sparkling stream at first, but no sooner coming in contact with things terrestrial than it generates mud—thick, or sometimes sloppy mental mud. But, as we have remarked, it does nobody any harm. No one need go to the meetings where abstruse mathematical papers are read, and no one need follow the rules which are given as the result of it all, if, indeed, the authors remember to give any rules."

It is, perhaps, not extraordinary that young students with the laurels of their graduation honors still fresh and green in their heads should write such papers ; the grievance which those of us who are growing old and have had experience of more or less value is, that these young fellows insist on reading such papers. We don't quite agree with *The Engineer* that they do no one any harm. Of course if young fellows who know a great deal about mathematics, but have never studied the laws nor the limits of elasticity of an ordinary audience, choose to write and read such papers, no one has any good ground to interfere if due notice is given of their dire intention. The trouble is that they don't give such notice. We go to meetings with the placid expectation that some one who has done something that is creditable and well worth doing will read a paper and tell us of the difficulties he encountered, and how he overcame them, and what he accomplished, its value, and many other things that would be entertaining or profitable, and after a reasonable amount of time—say 20 minutes—has been thus occupied, that then there will be a discussion in which the old fellows and the young ones will all tell without boring their audience, what they know or have learned or want to know and learn of the subject in hand. Such proceedings are agreeable and refreshing, and we come away feeling strengthened for the struggle which must be renewed daily. Instead of this what actually often does happen is, that some paper is announced with a taking title for a given meeting, which leads to the belief that the kind of diversion and instruction indicated will be dispensed. On such occasions it happens at times that some youth starts in on his manuscript. First he stands on one leg of a formula and then on the other. Then he gyrates about an hypothesis which he assumes to be a fact, and weaves a spider's web of integrations and disintegrations on the blackboard ; he balances possibilities in learned figures of speech, until none who hear him can tell whether he is trying to prove that the toes of his boots represent the square root of his understanding, or the end of his coat-tail is a function of his neck-tie. All we know is that what he is giving

us is totally unintelligible to the hearer, and we have a strong suspicion it is equally so to the reader. The authors of such papers are the chronic bores of technical associations. The reform which is proposed is that some committee should sit in judgment on the papers to be read. If they contain a little mathematics they should be designated by an X in their announcement, if more than a little by XY, and if much by XYZ, and then the said committee should provide cakes and ale in an adjoining room, to which members could retire while the author of the paper was practising his vocal exercises and his mathematical gymnastics.

TRADE CATALOGUES.

The enormous increase in this department of literature—if it be literature—within the present half of this century is one of the noteworthy phenomena of our time. Not only has it increased in quantity, but it has also been improved in quality. Some of the choicest examples of typographic and what may be called mechanical art or illustration will be found in trade catalogues. The paper, press-work, engraving, and descriptive matter in some of these publications are often of the very best, and attention has, in these pages, repeatedly been called to the fact that the best treatises extant on many subjects are such catalogues. Still, considering the fact that those who prepare and issue them are often possessed of more information concerning the subjects to which they relate than any other persons, it is somewhat remarkable that their work as authors or compilers generally has so little value, excepting perhaps in the limited sphere for which it is intended—that is, for selling the appliances or commodities which are described; and even that purpose, it is thought, is not accomplished as fully as it might be if the authorial work was better done. It may be said, though, that its deficiency is not generally due to a lack of knowledge of those who write, but more to a lack partly of what Herbert Spencer calls "constructive imagination" and power of expression. That writer, in the admirable memorial notice of the life of the late Professor Tyndall, which was published in *McClure's Magazine* for March, 1894, says:

"There prevail, almost universally, very erroneous ideas concerning the nature of imagination. Superstitious peoples, whose folklore is full of tales of fairies and the like, are said to be imaginative; while nobody ascribes imagination to the inventor of a new machine. . . . As rightly conceived, imagination is the power of mental representation, and is measured by the vividness and truth of this representation. . . . This constructive imagination, here resulting in the creations of the poet and there in the discoveries of the man of science, is the highest of human faculties. . . . Good exposition implies much constructive imagination. A prerequisite *is the forming of true ideas of the mental states of those who are to be taught*;* and a further prerequisite is the imagining of methods by which, beginning with conceptions they possess, there may be built up in their minds the conceptions they do not possess. Of constructive imagination, as displayed in this sphere, men at large appear to be almost devoid."

It is to the latter deficiency, chiefly, that the shortcomings of trade catalogues are due. An editor learns, perhaps sooner and oftener than other people, that that quality of mind which enables a person first to thoroughly comprehend a subject, and then enables him to assume the mental attitude with reference to it which a person ignorant of it occupies, is a rare one. Now the difficulty with most of the authors of trade catalogues is not that they have inadequate understanding of the subjects they write about, but that they can't conceive how it is regarded and appears to those who know little or nothing about it. They not only assume that their readers know more about the subjects which they are writing about than they really do, but the writers seem often to be oblivious of the fact of the total absence of knowledge in the minds of the persons they are writing for, or, as Mr. Spencer has expressed it, they are incapable of "forming true ideas of the mental states of those who are to be taught." It is nearly always safe to presume on the ignorance of readers, and it is seldom that writers explain things too clearly.

* Italics are ours.

Another curious fact is that persons who are unaccustomed to writing for publication sometimes have an idea that if what they write is to be printed, it would not quite fulfil its purpose if it was expressed simply and clearly and was easily understood. To give it the appearance of profundity they will make it incomprehensible. If the same persons should take a stranger through their shops they would probably give oral explanations of the construction, operation, or mode of manufacture of what they are producing which would be in every way clear and readily understood, or if they have occasion to write an informal letter of explanation or instruction, they will express themselves in the most lucid way, but if they are required to write anything for publication—to use an ordinary expression—they are apt to "mix things up."

Then there is another obstacle in the way of trade catalogues assuming the form and character which would make them most useful—that is, that their purpose is to aid in the sale of what is described in them. The animus of the salesman is nearly always behind them. Now modesty and reticence are not virtues which are cultivated too much by those whose business it is to make the merits of what they have for sale known. It is also generally true that the less experience and skill he has in his calling, the more is he likely to boast of the superiority of his "line" of goods. This becomes a habit, and when such people have occasion to prepare a descriptive catalogue of what they have or make for sale, they are very apt to follow their usual habit and begin by boasting and laudation of what it is the aim of the publication to sell. The general fact is recognized that it is difficult for a person who does not sell goods to give valuable instruction to those who do, but it is respectfully submitted that to begin a catalogue by boasting and explaining the character, the construction, the principles, the operation, or the uses of the appliances or commodities which it is one of the purposes of such publications to describe, is an inversion of the natural and logical order in which people's minds are influenced. Thus, suppose a salesman has a new kind of monkey-wrench, let us say, for sale. If in an interview he dilates at great length and eloquence on the merits of the wrench, what can be done with it, brags of its superiority over those which his competitor is selling, tells of how many orders he has received and how many he expects to get, and asserts that his wrench will work where no other wrench could screw or unscrew anything—all that is apt to fall on barren ground, unless the victim understands the construction of the wrench first. Explain to him how by some ingenious mechanical device all these advantages are attained, and he will be interested, and boasting may then do some good. The same principle applies to catalogues. If a person finds on the first page, in displayed type, the most fulsome commendation of the character, quality, and merits of the articles described, he is apt to feel that it is all rubbish and thrust it into the waste-basket. If, however, a tool or machine or some material which he uses is illustrated and clearly explained, so that it is easily understood, then commendation may find a place in his mind. For the composition of catalogues, and in selling anything, the general principle may therefore be laid down—explain first and boast afterward.

It may also be assumed that those for whom trade catalogues are intended are *not* thoroughly acquainted with "the state of the art" to which they refer. A brief and clear exposition of it brought fully up to date will generally be of interest to all who are concerned in the use of the articles described. A statement will then naturally follow of the improvement which it is the purpose of the catalogue to set forth. Trade catalogues, it seems certain, would accomplish their purpose more effectually and be of more general service

to those for whom they are intended if they assumed the character of elementary treatises, which some of them now do. If they did, there would be an almost boundless field of usefulness for them outside of their purpose of selling the articles described and lauded in their pages. If they were written by persons—as they generally are—who have devoted their lives to the subjects to which they refer, and if the aid of competent draftsmen was called in, such catalogues might become the most complete records of engineering progress in existence, and be the sources to which all would go for information. Their great defect now is generally the want of clear and full explanation and elucidation of the subjects to which they relate, although there are some notable exceptions to this. As technical education becomes more general, we may hope, and, in fact, can now see, that great improvement has been and is being made in this kind of literature. Much of it though has served to show how inadequate the instruction which is given in most technical schools is to enable their graduates to write clearly—a deficiency which it is to be hoped will be provided for. Capacity for lucid and adequate expression, either in writing or speech, is one of the most valuable qualifications a person can have for the battle of life, in which we must all take a part.

NATIONAL MANUFACTURERS' ASSOCIATION.

On another page the address or call for a convention of manufacturers, which is to be held in Chicago in October from the 15th to the 17th, is republished. This has been issued by Mr. Thomas P. Egan, of Cincinnati, the Vice-President of the Association, who is its author and also President of the J. A. Fay and Egan companies, the celebrated manufacturers of woodworking machinery. It will be seen, it contains the declaration that an organization bringing the manufacturers together to work for the common good of all, without party interests, but simply with the good of the country and its industrial welfare at heart, can be of incalculable value. To this patriotic sentiment we, and doubtless our readers generally, will respond with a hearty Amen.

It is said, further, in the manifesto which has been issued, that "the manufacturers propose never to allow themselves to be disregarded and their interests to be seriously affected by any action of Congress prejudicial to the good of the country without being heard from." That is right. If Congress takes any action prejudicial to the good of the country, the manufacturers should be the first to talk out. Such action, it is said, the last Congress did take when it "rescinded the valuable reciprocity treaties which were then in force, and framed a tariff under which it is almost impossible for the manufacturers to exist."

Now, if the latter statement is true, and if the remedial effects of reciprocity are what they are here intimated to be, the subject ought to be very fully discussed at the proposed meeting. At present there does not seem to be any general agreement among manufacturers about it. The commonly held opinion probably is that a little reciprocity is good, much is doubtful, and universal reciprocity would be deadly.

In some of the engineering and railroad associations which hold annual meetings the excellent practice exists of setting apart an hour of every session for the discussion of questions propounded by members. The manufacturers' convention might follow this practice with advantage to the interests of its members and the general edification of the public. The following questions might be suggested for discussion :

Would reciprocity be an advantage to manufacturers ?

How much of it would be good for them ?

If universal reciprocity is bad, how should it be limited ?

But is it true that it is almost impossible for the manufacturers to exist under the present condition of things ? Is it not, on the other hand, the fact that from every direction for months past there have come reports of improved business, higher prices—rails, for example—for products and wages, more employment of working people, and increased prosperity generally ? One of the things which might be done advantageously in Chicago would be to make a sort of diagnosis of the condition of the manufacturers in the country, and ascertain whether they are on the verge of dissolution. We don't believe they are ; and probably the companies of which Mr. Egan is the President are selling more or less on credit, as they have always done, with the expectation of being paid, and with comparatively little fear that their customers generally are on the verge of ruin.

Some strong confirmatory evidence, indicating that existence is not impossible for manufacturers in this country, comes from the other side of the Atlantic. In a recent number of *The Engineer* a letter from its Sheffield correspondent was published, in which it was said that :

"Some of our most experienced and observant manufacturers and merchants who have made frequent visits of late years, and particularly during the last 12 months, to the United States, anticipate much keener competition from that quarter than we have yet known. Steel billets have been ordered for delivery in Sheffield—not in any great weight, it is true, but to an extent quite large enough to show what might be done. Then, in regard to files, a larger user, whose works are in Sheffield, tells me that he has no other tools on his premises. He mentioned the brand which he finds so well suited to his purpose, adding that it was always true alike, and very much cheaper than anything he can get made on this side. These files are machine-made, the machines varying in size from that of a small striking apparatus to the more ponderous appliance required for the largest kind of files produced for the heavy trades. Female labor is employed. In one room he saw between 60 and 70 'lady operators' working at these machines, and turning them out in enormous quantities at prices with which no English market can compete. Here we are still fighting the battle of machine *versus* hand-cut, and, according to my information, the machinery we have in use has been discarded by the Americans years ago. The patentees declined to let English manufacturers use their inventions even under a royalty, intending to establish agencies for their files in Sheffield and other towns.

"Mr. Robert Belfitt, chairman and managing director of Messrs. George Butler & Co., Trinity Works, Sheffield—a firm with a district reputation for the production of fine art cutlery—has returned from a visit to the United States and Canada. It is the first visit Mr. Belfitt, who was Master Cutler a few years ago, has paid to these markets. He found what is not so generally known as it ought to be, that the Americans are manufacturing a great deal of their own cutlery, although for high-class goods they continue to call upon Sheffield. The reason for their not going in for the superior grade is, there is good reason to believe, not so much through inability to make them, but simply because, with their wonderful inventiveness and labor-saving appliances, they find it more profitable to concentrate their attention on lines of which great numbers are required. In fine pocket cutlery the orders are comparatively light ; but in the articles of every-day use the capabilities of the various United States markets are immense, and that is the trade the American manufacturer aims at getting. In this enterprise he finds the German the keenest rival ; but, with the advantages of duty and more effective appliances for production, as well as greater subdivision of labor, the German is being gradually displaced. The United States 'make' of secondary cutlery in general use there is daily increasing, and is being put upon the home markets of the Northern, Southern, and Western States at rates which secure the business for the American firms. Mr. Belfitt appears to have been particularly struck with the ingenuity of the Americans in the smaller lines of hardware, such as locks, door-knobs, and knickknacks useful in house-building and in the house itself. In these things he candidly admits the Americans beat us completely. Mr. Belfitt looks forward to a fairly good trade with the United States as well as with Canada."

This shows not only that we are holding our own, but that our manufacturers are able to assume an aggressive attitude and are able to compete with England in their own territory.

Since the first part of these comments were written the following items of news were received :

"As an evidence of the increasing prosperity among railroads and those engaged in the manufacture of railroad rolling stock, J. A. Fay & Co., the world-renowned and justly celebrated manufacturers of car and railway wood-working machinery, have to report an increasing business in this line. They are now furnishing machinery for the Mexican International Railroad Company, the Illinois Central Railroad, for their new shops at Burnside, Ill., the Queen & Crescent and the Big Four Railroads, Missouri Pacific Railway Company, Jacksonville, St. Augustine & Indian River Railway, and have recently equipped the new shops for the B. & O. S. W., at Washington, Ind., Pittsburgh & Lake Erie Railroad Company, Kansas City & Gulf Railroad, Mobile & Birmingham Railroad Company, Lenoir Car Company, at Lenoir City, Tenn., New York Central, for their Utica shops, and a number of others. They anticipate an increased trade in this direction for some time to come."

Certainly this indicates prosperity, which has come, apparently, in spite of what, in the call referred to, seems to be regarded as adverse legislation.

It would be extremely interesting if the views and the general sense of manufacturers could be ascertained, not only with reference to their present condition and the general business prospect, but also on some general abstract principles. The discussions in Congress, and by politicians generally, are shaped so much for the mere purpose of gaining party advantage that it is difficult to know what their views or those of their constituents really are.

If, for example, it could be shown clearly why an exchange of products with some people is good for us, while trading with others is very bad, it would throw light into places in which some persons now have difficulty in seeing clearly.

There are some other general propositions which might be discussed, perhaps to the edification, but certainly to the entertainment of the hearers, besides that one of when, where, and how an exchange of products is an advantage. The following are suggested:

Is the general prosperity of the community promoted by having commodities cheapened or endeared?

Should it be the aim of government, capitalists, and society generally to facilitate the beginning and the growth of new enterprises and aid in promoting their business and prosperity, or is the concentration of manufacturing and other business under the control of great corporations and firms a benefit to the country?

What are the principal obstacles which are encountered in the transaction of honorable business with such corporations and firms?

Could a practicable code of business ethics—similar to those in force among professional men—be formulated for manufacturers, and would it be possible, under an organization similar to the one contemplated by Mr. Egan, to hold them amenable to it?

Probably one of the most serious difficulties which manufacturers must contend with now is labor troubles and strikes. That this difficulty is not peculiar to our country, there is abundant evidence to show. At the recent meeting of the Iron and Steel Institute at Birmingham, England, a paper was read by Mr. Daniel Jones, Secretary of the South Staffordshire Iron Masters' Association, on "The Iron Industry of South Staffordshire," in which he said:

"No account of a great industry would in these days be complete without a reference to the methods adopted for regulating the wages questions. It is obvious that a district like South Staffordshire, which is placed under great disadvantages in respect to carriage, water in the mines and old works, cannot afford to run any risks of diverting trade by foolishly entering upon strikes and lockouts. This has been wisely taken into consideration by the leaders of the ironworkers and coal-miners, who are as well acquainted with the conditions of the trade as they were. Great credit is due to them that they should have so carefully studied the subject, and have formed such sensible conclusions as to what was best for their interests. As a result, we have wages boards both in the iron and coal trades, which have so far worked satisfactorily. This would be realized when he said that for 23 years they had been without a strike, in a district which was proverbial for them, and of a serious character. He must not forget to say that the principles upon which these wages boards have been founded were borrowed from the North of England Conciliation and Arbitration Board. From a long experience as the employer's secretary of the Midland Iron and Steel Wages Board, he strongly recommended to all the great trades of this country that they should adopt our methods. The principle is no longer to be considered experimental, but is established by a 23 years' experience with unfailing success; and the future of the South Staffordshire iron and steel trades is not so much a question, in his opinion, of supplies of coal and iron or of trade, as it is of the wisdom to be shown by both employers and employed with regard to labor questions."

No facts nor figures need be quoted to show that both here and in England the losses to employers and employed, resulting from strikes, is enormous. Regarded in the aggregate of a number of years, it has been in this country and in Europe a heavy expense which has been added to those which must necessarily be incurred in the transaction of business. Therefore manufacturers who can avoid strikes have a great advantage in competing for business over those who are subjected periodically to this kind of interference, with all its attending loss. Therefore, what Mr. Jones has said of the importance of wisdom in dealing with the labor question applies not only to the industries of South Staffordshire, but to those of the whole world. If the iron manufacturers of England deal with this subject more wisely than those do who expect to assemble in Chicago, the former will be in a better position to compete for the business of the world than the latter. It therefore seems to be of the utmost importance that the manufacturers should form the wisest possible opinions on this subject, to be succeeded when the occasion arises by correspondingly wise action. Unfortunately for us our great civil war left a heritage in the very commonly held opinion, that all social and political evils may be settled by fighting. The great issues which brought about that unhappy contest between the two sections of the country were decided by bloodshed, and many people hastily reason that if such great questions were thus decided, lesser ones may be submitted to the same kind of determination; and now whenever there is a strike or a rumor of a strike, the first thing that some people demand is to call out the military. The manufacturers and their employés in England, by long and bitter experience, have learned wisdom, and as indicated by the observations which have been quoted, they now aim to settle such disputes, not by violence, but by the peaceable ministrations of boards of conciliation and arbitration. The practical effect of this is to reduce the cost of production, by avoiding the wasteful expense of strikes. There is no subject which is more worthy of consideration by the manufacturers at their Chicago meeting than this. If some new method of manufacturing had been discovered and was used in Europe which materially reduced the cost of production, hardly any expense would be spared by our manufacturers here to learn all about it. Now, as a matter of fact, the methods which have been adopted in Europe for settling labor disputes have materially lessened the number of strikes there, and thus reduced cost. Would it not be worth while to study the methods to bring about such results by appointing some kind of commission, and have them make a tour of investigation and report on what has been done and on the methods employed, in other countries, to avoid labor troubles and establish industrial peace instead of war? It looks as though more reciprocity, more general knowledge of the underlying principles of exchange, more fair play in trade, more conciliation and arbitration, and compromise—if need be—would do more for the general prosperity of manufactures than anything else which the association that will meet in Chicago can promote.

NEW PUBLICATIONS.

"THE UNIVERSAL DIRECTORY OF RAILWAY OFFICIALS, 1895. London: The Directory Publishing Company, Limited, 8 Catherine Street, Strand, W. C. 342 pp., $5\frac{1}{2} \times 8\frac{1}{2}$ in., 10 shillings.

This attempt to make a universal directory of railway officials, it is said in the preface, is believed to be the first one which has ever been made. It is certainly very much needed, and will be of great use to all who have business or other relations with railroad companies and their officers. It is said to contain upward of 8,500 directors and chief officials, including the chief clerks and chief draftsmen.

The table of contents shows that the countries included are England and Wales, Scotland, Ireland, Europe, Asia, Africa, Australasia, North America, Mexico, Central America and West Indies and South America.

Of course, with the great mass of material which had to be handled, but little typographical display was possible. The names and addresses which are given are, therefore, printed in small type, but which is quite legible with good eyes or good glasses or both, excepting in some cases where the printing is bad, which is the case on some of the pages, although generally the work is fairly well done. The book fills a long-felt want, and its success is probably assured.

ADDRESS OF R. T. CRANE TO HIS WORKMEN, JULY 4, 1895. 15 pp., $5\frac{1}{4} \times 7\frac{3}{4}$ in.

Last Fourth of July Mr. R. T. Crane, President of the Crane Company, and also of the Crane Elevator Company, of Chicago, told his employés that just 40 years before, on the Fourth of July, 1855, a furnace which he had built for a brass foundry was ready, and being anxious to see that it worked all right, he took off his first heat on that day. The anniversary of that event he made the occasion of an address to his workmen, in which he advocated peace and good-will between employer and employed. In this address he calls attention to the untold anxiety and worry which a person must endure in building up a successful business. If the difficulties of carrying on a great business could be instilled into the minds of workingmen, so that they would realize them fully, it would be a great gain; but with the very limited range of experience and the moral and mental qualifications of many employés such an appreciation is difficult or impossible.

The solution of the labor question or the adjustment of the relation of the employer and his employés must be by evolution, and that is a slow process. Mr. Crane's address has probably helped this along, as all honest efforts do.

In reading addresses of this kind, though, it often seems as if more would be gained if the speakers, instead of preaching in favor of peace and good-will, would advocate fair play on both sides. The difficulty generally is that there is not sufficient disposition or capacity on one or either side to deal justly or *righteously* with the other. Amicable agreement is, then, difficult or impossible.

Mr. Crane ends with the prediction that if the famous mechanics, artisans, and laboring men should adopt and enforce legislation that will deny their rights to one class of a community while guaranteeing them to another class, just so certainly will this republic of ours become a memory, and despotism will follow; which is doubtless true, but the hypothesis is a two-legged one, and Mr. Crane's boot would fit either.

AN ELEMENTARY TEXT-BOOK ON STEAM ENGINES AND BOILERS. For the Use of Students in Schools and Colleges. By I. H. Kinealy, Professor of Mechanical Engineering, Washington University, St. Louis, Mo. New York: Spon & Chamberlain. 236 pp., $6 \times 8\frac{3}{4}$ in., $2.00.

There is a class of books which always recalls Lincoln's immortal story of the Kentucky Baptists, who were too bad to be saved and too good to be damned. The one before us belongs to this class. The author tells us it "was written solely as an elementary text-book for the use of beginners and students in engineering, but more especially for the students in the various universities and colleges in this country." Now, if it was intended for an elementary book for beginners, why was it sprinkled with mathematics, which, to say the least, is not easy reading for a beginner? If, on the other hand, it was intended for "students in universities and colleges," it would seem, from some of the observations it contains, as though a certain amount of imbecility of mind was assumed in that class. Why, for example, should such students be told that "some slide-valve engines are heavy, well made, and made of good material; others are slight in weight, poorly made and made of the poorest material," and that "the cylinders of engines are made of cast iron, with walls sufficiently thick to stand the stress induced by the pressure of the steam," etc.

Can it be imagined that any students ever present themselves at Washington or any other university who require instruction like the following?

"The boiler is simply a closed vessel which contains the water of which the steam used in the engine is formed. The boiler may be of any shape or size.

"The chimney is the part which carries off the products of combustion.

"The fuel is put in the furnace on the grate, and is there burned. During the combustion of the fuel heat is generated," etc.

This sort of writing for "students" is simply twaddle. Then the explanations often do not explain. Supposing a student who does not know what an eccentric is should be told, as he is in this book, that "the eccentric is simply a cast-iron disk through which the shaft passes, and which moves the valve of the engine," what sort of an idea would he form of that important part of a steam engine's mechanism?

The book seems to have been constructed on the pigeon-hole system—that is, when the writer found anything relating to the general subject he made a note of it and put it into a pigeon-hole or other receptacle. When this was filled he classified the material, divided it into chapters, and had it printed, and now labels it as intended for students.

The engravings are mostly reproductions—and bad ones at that—of engravings from advertising catalogues; one of them, on page 60, is printed upside down.

The subjects treated of in the different chapters are: Elementary Thermodynamics; Theory of the Steam Engine; Types and Details of Engines; Admission of Steam by Valves; Valve Diagrams; Indicator and Indicator Cards; Compound Engines and Condensers; Heat and Combustion of Fuel; Boilers and Chimneys, all of which are better elucidated in other books. An appendix is devoted to the Care of Boilers. It is to be regretted that the excellent "Instructions to Boiler Attendants," issued by the Manchester Steam Users' Association (which we have reprinted in the form of a "reference card"), did not find its way into the pigeon-hole referred to, and was not added to the appendix, as it would have increased the value of this part of the book, it may be said roughly, about 500 per cent. The climax of inferiority is reached by the omission of an index.

REPORT OF THE PROCEEDINGS OF THE TWENTY-NINTH ANNUAL CONVENTION OF THE MASTER CAR-BUILDERS' ASSOCIATION, held at Alexandria Bay, New York, June 11, 12, 13 and 14, 1895. John W. Cloud, Secretary, 974 Rookery, Chicago, Ill. 437 pp., $6 \times 8\frac{3}{4}$ in. [Not quite standard.]

This report comes to us this year bound in stiff paper covers, which is a great improvement. A review of the contents would take more time and space than can now be given to it, but we can afford the observation that the amount of care and labor which must be given to the preparation of the great quantity of copy which is condensed in the pages before us only those who have done the work can realize. The master car-builder or railroad superintendent who receives his bound volume all complete and arranged in convenient form for use and reference should fold his hands and close his eyes for a moment, or, better still, write a note and express his thanks to the Secretary for the work which he has done. The typography, engraving and general arrangement are all excellent, and it would be possible to meander into comments indefinite on the contents, but for this there is not time either for the writing or probably for the reading.

It is generally more profitable to observe our faults than to contemplate our merits. Perhaps the same is true of books—at any rate, from the reviewer's standpoint. Although the more permanent binding is appreciated, the lettering on the back might be improved. The title is simply "M. C. B. Ass'n, Vol. 29, 1895." Now, while all the members of the Association and others perhaps know what these cabalistic letters mean, to the great majority of mankind they will be as Greek or Sanskrit. These reports will go into libraries, public and private, and will be kept there for reference. Is it at all likely that a reader in, say, the Astor Library, or that of the Institution of Civil Engineers, or British Museum in London would know what M. C. B. means? For the convenience of members, too, the place where the meeting was held should be inscribed on the back. Most of us can identify a given meeting five or ten years after it was held much better by some association with the place than by the ordinal number of the meeting.

There would seem to be room for improvement, too, in the quality of the paper. A principal component of that in the book is wood pulp, which in 10, 20, or 50 years will decay or be so brittle that it cannot be handled without destruction. These reports are not of a merely ephemeral character, but should be permanent records of what the association has done. The de-

velopment of railroads is one of the great facts of history and the advancement of civilization, and in the future what the Master Car-Builders' Association has done will be a matter of interest to those who will come after and succeed us. It would therefore seem to be worth while to preserve its records in some form which will not speedily go to destruction.

Lastly, the index is inadequate for a book of reference of this kind. It ought to be possible from it to find any important subject referred to in the volume. Take as an example screw threads. How many people are there outside of the Association to whom it would probably occur to refer to the word "standards" in order to find what the Association has done about screw threads. Or suppose it is desired to find what some member said on a certain subject. Not one of the members' names are indexed in connection with the discussions. It is doubtful whether people who make good indexes will get their reward in this world—in fact, it is quite certain they will not—but if things are "evened up" hereafter they will probably be honored then and there, wherever that may be, and have some kind of new and improved spiritualized electric-lighted halo of greater brilliancy than the other chaps who have not made good indexes.

THE MICHIGAN ENGINEERS' ANNUAL, *Containing the Proceedings of the Michigan Engineering Society for* 1895. Published by the Society, F. Hodgman, Secretary, Climax, Mich. 224 pp., 5¾ × 8½ in. [Not standard size.]

The time seems not far off when every State in the country will have its own local engineering society. The volume before us is an indication of this. We have here a well-printed book containing the following papers: Waste and Consumption of Water, by G. S. Williams; New Lock at Sault Ste. Marie, by J. L. Callard; Title by Possession, by Judge F. A. Hooker; Difference in Direction of Magnetic Needles, by C. L. Berger, L. Bechman, W. and L. E. Gurley, and F. Hodgman; Cement and Concrete, by V. Sebring Hillyer; Difficulties in Manufacturing, by C. E. Bement; Old Surveys in Detroit, by Thomas Campan; Highway Bridges, by H. K. Vedder; Special Assessments, by M. C. Taft; Grand Rapids Plaster Quarries, by C. H. Redman; Sewer Building at Port Huron, by F. F. Rogers; Mineral Resources of North Arkansas, by E. L. Hayes; The Austin Masonry Dam, by E. W. Groves; Highway Grades, by John Randall; Logging Railroads, by H. C. Thompson; Work of the Propeller Wheel, by H. C. Pearsons; A Hard Tramp, by F. Hodgman; A Queer Man, by F. Hodgman; and What I would Be, by F. Hodgman.

The volume, as has been said, is well printed in good large clear type. The binding, however, is of that execrable kind which holds the leaves together as though they were riveted—as they are by wire—and they require to be pried apart in order to read comfortably on the inner margin. On the outside there is a margin over an inch wide, while on the inside the accessible margin is only about ¼ in. This is a very common defect of books, issued even by the most prominent publishers. If one half of the outside margin had been put on the inside, the pages could be read with comfort. As it is, the wire binding and the narrow inside space are irritating to the reader.

Another defect of the book is that there is no index—only a table of contents, which suggests a story: the writer in his early days, like many other boys, good and bad, went to Sunday-school. There are conflicting traditions bearing upon the question whether he was numbered among the former or the latter—probably there was in him the usual mixture of cussedness and imbecility characteristic of boys in the active period of life, and he doubtless assisted his companions in making the lot and duties of the superintendent of the school unhappy. The functionary who acted in that capacity was an elderly, fat, pious and solemn individual named Martin Lohr. The sessions of the Sunday-school were held in a basement lecture room, which occupied one-half of the space below the general meeting room of the congregation, which was above. In the other half of the basement the hot-air furnaces for heating the church were located, and, as a consequence, it was nearly always filled with a suggestive sulphurous odor, which escaped from the anthracite coal that was used as fuel. The biers which were then used on funeral occasions, the tools for grave-digging, and other uncanny appliances were stored in this place. One Sunday, after the boys had been more than usually insubordinate, the venerable superintendent lectured them for some time, which had no effect; he then scolded, at which they were not awed; until finally in desperation he said: "If you boys do not behave better I will fit up a little hell in the adjoining furnace room and have some of you shut up in it." The threat was so dreadful that memory fails to recall whether the conduct of the boys was improved thereby; but in looking over books, which of necessity must be used as references chiefly, and which are indexless, we are led to hope that some literary Martin Lohr might arise and establish a place of punishment for authors and publishers who are guilty of such delinquency.

BOOKS RECEIVED.

EXAMINATION OF WATER FOR SANITARY AND TECHNIC PURPOSES. By Henry Leffman, M.D. Third Edition. Revised and Enlarged with Illustrations. Philadelphia: P. Blakiston, Son & Co. 154 pp. 4⅞ × 7¼ in., $1.25.

TRADE CATALOGUES.

[IN 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. The advantages of conforming to these sizes have been recognized, not only by railroad men, but outside of railroad circles, and many engineers make a practice of immediately consigning to the waste-basket all catalogues that do not come within a very narrow margin of these standard sizes. They are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

STANDARDS.

For postal-card circulars	3¾ in. × 6⅛ in.
Pamphlets and trade catalogues	3½ in. × 6 in. 6 in. × 9 in. 9 in. × 12 in.
Specifications and letter-paper	8¼ in. × 10¾ in.

WOOD WHEELS GRINDING AND POLISHING MACHINERY. Builders' Iron Foundry. In two leaflets this company announce that they have installed machinery for the manufacture of wooden wheels covered with heavy oak tanned leather for polishing metal and other work. A cluster of these wheels is represented in one of their publications.

RED LEAD AND HOW TO USE IT. By Ralph K. Wing. National Lead Company, No. 1 Broadway, New York. 24 pp., 4¾ × 7¾ in. [Not standard size.]

In this well-printed pamphlet Mr. Wing, the travelling representative of the National Lead Company, has compiled the opinions of various experts on the uses and advantages of red lead for painting iron or steel, and also sets forth some of the disadvantages of other kinds of paint. Some account of actual tests made by various paints and samples, showing the color of pure red lead and combinations with various proportions of lamp-black, are given. Short chapters on the Economy of Red Lead; Mixing; Preparing Iron for Painting, and Purity and Quality of Paint complete the book.

CATALOGUE OF COLD SAW CUTTING-OFF MACHINES. Newton Machine Tool Works, Philadelphia. 32 pp., 6 × 9 in. [Standard size.]

Probably very few machinists or mechanical engineers will look through this book without being surprised at the variety of cold sawing machines and the uses to which they are adapted. In the catalogue before us no less than twenty-six different cold sawing machines are illustrated and described, besides a band sawing machine, also intended for metal.

An idea of the work which can be done on these machines will be obtained from the following extracts from the descriptions:

No. 0	machine will cut round bars up to 2 in.;	square up to 2	in.
No. 1	" " " " " " " 3½ "	" " " 3	"
" 2	" " " " " " " 5 "	" " " 4½	"
" 3	" " " " " " " 7 "	" " " 6	"
" 4	" " " " " " " 9 "	" " " 8	"
" 5	" " " " " " " 12 "	" " " 11	"

" 1	I-beam machine will cut off beams up to	15 in.
" 2	" " " " " " " "	20 "
" 3	" " " " " " " "	24 "
" 4	" " " " " " " "	12 × 38 "
" 5	" " " " " " " "	15 × 56 "
" 6	" " " " " " " "	18 × 60 "

Other machines for special uses are made and illustrated, some of which can be used as cutting-off machines and as rotary planers. What is called a stock-yard machine, which is intended to take the place of high-speed or friction cold saws in steel and iron works, is also illustrated and described. Besides these the company makes a machine designed for trimming the edges of armor plates after they come from the rolls. Still others which are illustrated are for cutting off the heads and sprues of large steel castings, and for cutting off car and loco-

motive axles. The last illustrations are of saw sharpening machines. A good index completes the pamphlet. The illustrations are fair wood engravings, which show the machines very well, but are not of superlative excellence.

TOBIN BRONZE. The Ansonia Brass and Copper Company, 19 and 21 Cliff Street, New York. 36 pp., $3\frac{3}{4} \times 5\frac{3}{4}$ in. [Not standard size.]

On the first page of this pocket pamphlet the publishers say that they furnish Tobin bronze in the following forms: Pump Piston-rods and Yacht Shafting, Rudders, Centre Boards, Pump Linings, Condenser Heads, Fin Keels, Tube Sheets, etc., Round, Square and Hexagon Bars. In several pages which follow the qualities and characteristics of the metal is described; tables of weight, reports of tests, and a cloud of testimonials are given, from which the reader can learn more than he ever knew before about the merits of this metal; and if he happens to be an engineer, he will doubtless learn something which will be to his advantage.

BAKER HOT WATER NON-FREEZING CAR HEATERS. William C. Baker (Inventor), 143 Liberty Street, New York. 96 pp., 6×9 in. [Standard size.]

The animus of this publication is so well set forth in its preface that we cannot forego the opportunity of quoting from it. It is said:

"In the year 1866 Mr. W. C. Baker invented and introduced the now universally used Baker car heater. This heater was the first innovation on car stoves. Since 1866 there had been no improvement on the Baker heater until 10 years ago, when he commenced making and putting into use the important improvements described in this book. His efforts have culminated in the production of a jointless, flexible, and absolutely fireproof heater, which cannot be broken in a wreck."

The catalogue before us is intended to describe and set forth the merits and characteristic features of this heater.

The original Baker heater is too well known to require description. As all railroad men know, it consisted of a stove with a coil of pipe inside, which surrounded the fire, and through which water was circulated and warmed, and then conducted through pipes below the seats, thus heating the car. This feature is still retained, and, as Mr. Baker says, "the fire chamber is surrounded by the generator coil filled with water. An air space outside of this coil is for the hot gases of combustion. Next is a sheet-iron casing, then sheets of non-combustible asbestos, and outside of all"—and herein is the important safety feature—"is the flexible, jointless steel casing one-fourth of an inch thick." This is made of soft steel, and will bear any amount of bending, doubling, or twisting without breaking. The steel casing is seamless and of cylindrical form, the top and bottom of which are also made of the same material. The smoke escapes through apertures in the top—which is also made of soft steel—$\frac{5}{8}$ in. in diameter, and these are the only openings through which fire could escape in case of an accident. This form of heater Mr. Baker claims gives complete security against fire in case of accident, and has the advantage of greater efficiency for heating cars in storms when trains are delayed than heating with steam from the engine has, gives a pleasanter heat, and is capable of better regulation.

Various forms of this heater are described and illustrated, and full detailed views of the various parts are given for convenience in ordering duplicates.

A new style of generator, the form of which may be understood if the reader will imagine two hollow rings of brass placed one above the other, with a space of about 12 in. or 15 in. between them. Now imagine these rings connected by vertical conical pipes—that is, pipes of this form—the wide ends of which are connected to the upper ring and the small ends to the lower one. These are filled with water which circulates through them. The rings are divided diametrically into two halves, and the half of the upper one and the half of the lower one, with the pipes connecting them, are all cast in one piece, and are therefore without joints excepting those by which the water pipes are connected to them. Mr. Baker is anticipating much success from this form of heater.

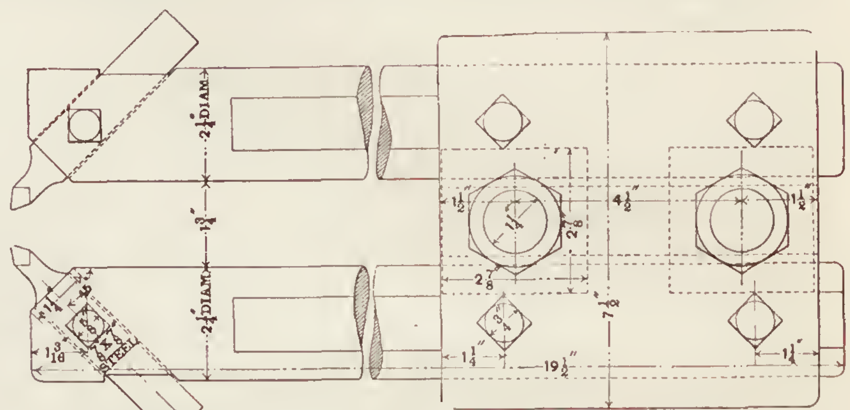
The illustrations in the book are excellent wood cuts, and the descriptive matter has that piquancy which is characteristic of the author's writing, speech and inventions.

The only criticism which we feel is needed is of the nature of a suggestion, and is, that if a sectional view corresponding to the exterior view on page 1 had been given, showing the internal parts of the heater, it would have aided those who are ignorant of its construction to understand how it is made, and with a suitable explanation would have enabled them to understand better how it works. It is nearly always safe to presume upon the ignorance of your readers.

NOTES AND NEWS.

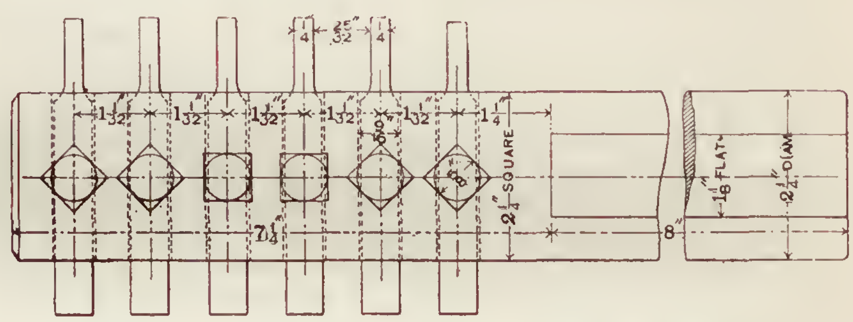
The Ram "Katahdin's" Trial Trip.—It is announced that the trial trip of this vessel, which was built by the Bath Iron Works, in Bath, Me., will take place on October 3. She will be run for two consecutive hours, and to fulfil her contract requirements must maintain an average speed for that time of 17 knots per hour.

Tools for Turning and Cutting off Piston Packing Rings.—There is in use in the shops of the Baltimore & Ohio Railroad a very convenient device for turning and cutting off piston packing rings, engravings of which are given herewith. After having bolted the casting, from which the piston packing rings are to be cut, to the face plate of the lathe, the first operation is to turn off and bore out the casting at one



TURNING TOOL FOR PISTON PACKING RINGS.

and the same time with the double tools, as shown in the sketch, taking rough and finishing cuts, the tools being set for finishing cut, the proper distance apart to give the required thickness of packing ring. Then the bar with the cutting-off tools is placed in the tool-holder, the cutting-off tools are so spaced as to leave a slight amount to be faced off the rings as the final operation.



CUTTING-OFF TOOL FOR PISTON PACKING RINGS.

All the cutting-off tools are brought into operation at the same time, but are not forced entirely through, sufficient metal being left to hold the several rings together. The tool in the end of the bar is then placed in the first groove and used as a facing-off tool, reducing the ring to the proper width and finally cutting it off; this same operation is gone through with each ring.

How the 4 ft. $8\frac{1}{2}$ in. Gauge for Railroads was Fixed.—A number of versions of the origin of what is now the standard distance between the rails of modern railroads are current. The following from an English paper is the latest:

"It is said that when the bill for the London & Northwestern Railway was before the Parliamentary Committee the chairman pointed out that nothing had been said about the width of the gauge.

"The committee were just adjourning for lunch, and counsel for the company promised that the required particulars should be supplied when the committee reassembled.

"A hasty consultation took place, and they went out into the street at Westminster and measured the wheels of one of the old road wagons which used to ply between London and the provinces. It was found to be 4 ft. $8\frac{1}{2}$ in. wide, and that measurement was inserted in the Railway Bill."

A more reasonable and probable one was given by correspondents in the *English Mechanic* some years ago. It was

that the gauge of the Liverpool & Manchester road was originally 5 ft. measured to the outside of the rails, which were 2 in. wide, making the inside gauge 4 ft. 8 in. It was found that in going round curves the cars and locomotives had not sufficient room between the flanges and the rails, and the distance between the latter was therefore widened ½ in., making the gauge what it is now, 4 ft. 8½ in.

The Slipping of Wheels.—A correspondent from Baltimore writes to inquire whether "when an engine is rounding a curve, do the driving-wheels on either side slip or slide? If so, which ones slip, and in what direction; or whether the cone shape of the tire and the fillet of the flange increases and diminishes the size of the wheels so as to allow them to pass in and out of curves without either of them having to slide? Also advise what bearing the elevation of the outside rail of a curve has on the subject."

If our correspondent will watch an engine or a car truck when it is moving slowly on a sharp curve, he will find that the flange of the front wheel next the outer rail will impinge against it, and that this forces the front pair of wheels laterally across the track and toward the centre of the curve. In other words, these wheels slip endwise. This movement of the front pair of wheels produces a twisting action on the rear pair of wheels on, say, a four-wheeled truck, which causes them to turn slightly about a vertical line drawn through the centre of their axle midway between the two wheels. The hind wheels, therefore, slip slightly, the one on the outer rail moving forward and that on the inner rail backward. With a six-wheeled truck or engine with six drivers, the middle pair of wheels would also slide sideways, but only half as far as the front ones do in a given time or distance, and there will also be some twisting action exerted on them, but not so much as on the back pair of wheels.

The coning of the wheels has an almost inappreciable effect on car or engine wheels in rolling around a curve. If the axles could assume a position radial to the curves, the cone of the wheels would help them around; but if the axles remain parallel to each other, the cone has an almost inappreciable effect, as was fully shown in a paper read by the writer at a meeting of the Master Car-Builders' Association in 1884, and which will be found on page 39 of the report for that year.—Editor.

Electric and Steam Railroad Competition.—Some idea may be obtained of the nature of the competition between the steam and electric railroads in the vicinity of New York from the following table, in which the distance, fare, time consumed in the journeys, and interval between trains are given. The fares, it will be seen, are about 25 per cent. less, but the time consumed in the journeys is nearly doubled. But, on the other hand, the intervals between trains on the electric roads are only one-sixth to one-twelfth as long. Obviously such competition is a serious matter to the steam roads.

From New York to	Distance.	Fare, Round Trip.		Time.		Interval between Trains.	
		Electric.	Steam.	Electric.	Steam.	Electric.	Steam.
	Miles.	Cts.	Cts.	Min.	Min.	Min.	Min.
Greenville	4.2	15	20	40	18	5	30
Bayonne	7.7	15	25	60	27	5	30
Newark	9	20	25	50	30	5	30
Orange	12	30	50	80	45	5*	30†
Elizabeth	12.5	35	50	80	40	5*	60
Bloomfield	13	30	45	80	50	5*	60

A Mountain Electric Railway.—A correspondent of the London *Times* gives some further details respecting the new electric railway from Laxey to the summit of Snaefell, Isle of Man. The length of the new line is about 4¾ miles with a remarkably even gradient throughout. To insure steadiness and safety the company have adopted the Fell system of centre rail. The bearing rails, laid to a gauge of 3 ft. 6 in., are of Cammell's best quality of steel, 50 lbs. to the yard. Between these a double-headed rail (65 lbs. to the yard) is laid on its side, upon chairs, and is thus somewhat higher than the bearing rails. Upon the bogies of the cars are two sets of double wheels which clasp the centre rail and run along it; and also two gripper brakes manipulated from the driver's cabin in augmentation of the ordinary brakes upon the eight wheels of the bogies. The system has not been adopted in the United Kingdom before. The generating plant consists of four Lancashire boilers of 150 H.P. each; five horizontal compound engines of over 100 H.P. each; and five (55) Kilo Watt dynamos of the Mather and Platt type, with Edison-Hopkinson magnets and Manchester armatures. Each dynamo is shunt wound for an electro-motor force of 550 volts at a speed of 800 revolutions per minute. The magnet limbs are of best selected well annealed cast steel. The magnet coils are wound upon separate spools removable from the limbs. The armature has Bessemer steel shaft, copper commutator insulated with mica. Sections are provided with two brushes on each rocking arm, each separately adjustable, with spring forward thrust and hold-off catch. The area of the cable is calculated on a basis of 1,000 ampères per square inch when loaded to the *maximum*. The accumulator station is fully equipped with an installation of 240 cells of patent chloride type. The generating plant is of sufficient power to work three or more cars, each loaded with 48 passengers, running at a speed of 8 or 8½ miles per hour under normal conditions of rails and weather. The overhead wire system has been adopted. These conductors consist of No. 0 Birmingham wire gauge, high-conductivity, hard-drawn copper wire, and are carried upon suitable insulators supported in clips attached to cross arms of steel poles between the rails. Each car has four No. 5a Manchester dynamo motors, two upon each bogie, one for each axle. These are geared with single-reduction steel, with pinion and wheel; and are fitted with Mather and Platt's patent carbon brushes. The driver's cabins, at each end of the car, have controller for stopping, starting, and reversing; with emergency switch, ammeter, and suitable resistances for regulating speed, and for stopping and starting.

* Change at Newark. † Every 30 minutes morning and every 60 minutes rest of day.

The First-class Battleship "Prince George."—The *Times* gives the following description of this ship, which was recently launched from the Portsmouth yard. The principal dimensions of the ship are: Length between perpendiculars, 390 ft.; breadth, extreme, 75 ft.; mean draft of water, 27 ft. 6 in.; displacement when fully equipped, about 15,000 tons. She will be fitted with twin screws, each of which will be driven by an independent set of engines with three vertical cylinders and of 6,000 H.P., giving a total H.P. of 12,000 for both sets of engines, with a working pressure in the boilers of 150 lbs. per square inch, and an air pressure in the stokeholds equal to 1 in. of water. The amount of coal usually carried is 900 tons, but the vessel has a total stowage capacity of 2,220 tons. The disposition of her protective armor is similar to the *Majestic's*, the arrangements combining the advantages of the turtle-back deck of the cruisers with those of the citadel armor of the former battleships. The ammunition is also supplied to the guns through passages and trunks which are all either constructed of armor or are under protection of armor. The advantages gained by this arrangement over the unprotected broadside are obvious. The ship will be fitted with two masts, with two fighting tops on each. Each top will carry three 3-pdr. quick-firing guns, with the necessary magazines and equipment. Each mast will also carry on a platform at its head a powerful electric light for signalling and searching purposes. The *Prince George* will be fitted with the new 12-in. breech-loading steel and wire guns, which, though much lighter than the type fitted in previous battleships, will surpass them in power of penetration, and in consequence of their reduced weight will enable all fittings in connection with them to be reduced in size, rendering the whole of the machinery much lighter and easier to work, efficiency being thereby proportionately increased. These guns will be fitted in pairs in two armored redoubts, one at each end of the ship, and will be mounted on revolving turn tables, the whole being worked either by hydraulic or hand power. These guns will be protected by an armor shield 10 in. thick, as in the *Majestic*, an advantage not possessed by previous battleships of this size. This vessel will also carry twelve 4-in. quick-firing guns, mounted in casemates, protected by 6-in. Harvey armor, eight of which are on the main deck and four on the upper deck. Each gun and its crew will thus be completely isolated from the others, orders being communicated from the central fighting station by means of a system of voice pipes. Sixteen 12-pdr. quick-firing guns will be also mounted on the main and upper decks, and the vessel's armament will be completed by the twelve 3-pdr. quick-firing guns in the military tops, by two 12-pdr. boat and field guns, and by eight .45 in. Maxim guns mounted in suitable positions; 22 torpedoes will be carried, which can be fired from four submerged tubes, two forward and two aft, and one above-water tube at the stern. Six search-light projectors, worked by three dynamos, each of 600 ampères, will be carried. Ten steam fans will be fitted for the purpose of ven-

tilating the working and living spaces, two for ventilation of the engine-rooms, and eight for furnishing the forced draft for the boilers. The vessel will have a complement of 757 officers and men.

A DEVICE OF VALUE TO INDICATOR-CARD TAKERS.

Editor AMERICAN ENGINEER AND RAILROAD JOURNAL:

Mr. E. F. C. Davis, whose sad and sudden death was referred to in the September issue of this journal, was a man full of devices for overcoming mechanical difficulties and for smoothing rough roads in applying theory to practice in engineering. In the matter of the study of the steam-engine from the indicator card, he had a very extensive experience, and has taken personally about as many cards from locomotive engines as any man in the country, and to him the writer, as well as many others, is indebted for a very useful little suggestion pertaining to card-taking, which has proved to be a "friend in need" many times, and which will undoubtedly be appreciated by many readers of the AMERICAN ENGINEER.

We all concede that inaccurate data is frequently worse than none, and no engineer will acknowledge that he does not desire to know just what the engines in his charge are doing. The truth is that accurate and useful data is rare because, and only because, it takes time and trouble to obtain it, and few are willing to spare the one or endure the other unless pushed to it or paid for it.

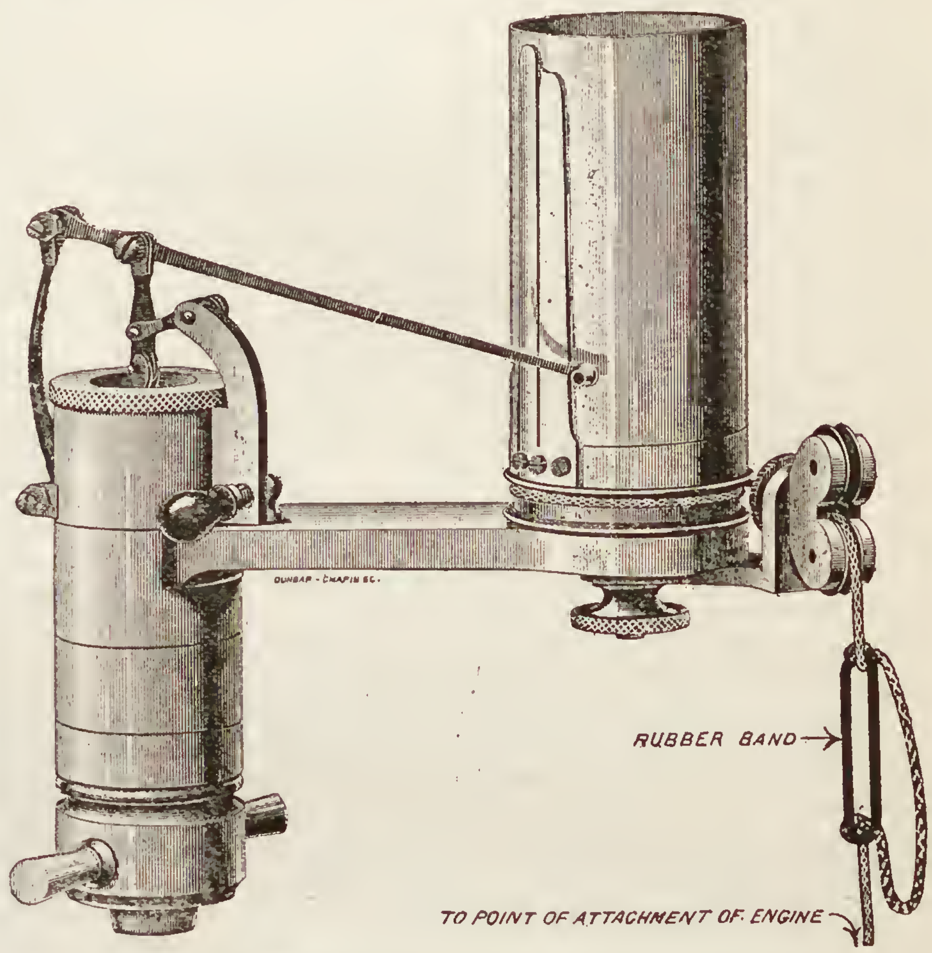
The indicator card, if properly and carefully taken, tells us much that we want to know, yet there are not many among those who use this method of obtaining information on the performance of engines who really appreciate the delicacy of the operation and the great importance of proper preparation. For instance, a heavy or light pressure of the pencil on the card will make the greatest difference in the resultant H.P., as well as give lines very misleading to the student of the card. The writer has frequently tested this, and has obtained successive cards from engines running at very uniform speed that varied as much as 10 per cent. in mean pressure, and that without any really excessive pencil pressure. The pencil must scarcely touch the surface, and good cards must necessarily be light ones. When it comes to taking cards from engines running at from 200 to 500 revolutions per minute, other difficulties arise, and it is mainly to these troubles that Mr. Davis's device is directed.

It is always desirable to obtain cards with but one or at least very few revolutions marked on them, and it is not necessary to have locomotive diagrams made with a broad race-track of pencil marks to average results from, as is generally the case. The principal cause of these multiple cards lies in the difficulty in taking off and putting on the cards while the engine is running, as the cord is liable to catch and break when running slack while the barrel is held still.

The manner in which Mr. Davis arranged the indicators is so simple and yet so thoroughly effective, that all who try it will always use it where more than a single card is desired, and as it is not a patent we will describe it here for "all comers." The accompanying figure will serve to show the method of adjustment.

The indicator used must, of course, be provided with a detent (or pall and ratchet) for holding the barrel at its fullest throw in order to change cards. The pencil must be fairly hard and ground to a "round," fine point, and not a sharp, cutting point. It must be adjusted by the screw-handle to just faintly bear on the card when held firmly against the stop, so that varying hand pressure does not enter into the conditions at all. The engine is turned so that the point which gives motion to the cord is at its fullest throw, then the cord is passed through the pulley on the indicator barrel and tied just below the pulley to one part of an ordinary rubber band ½ in. wide and 2½ in. long, this size suiting all ordinary indicators. The cord is then led to the point it is to get its motion from, and after pulling it until the card drum is within ½ in. of its full throw it is secured to that point. The engine is now turned exactly one-half of a revolution, and the rubber band is stretched to 3 in. (about ½ in. real stretch), and the point of the cord opposite the lower end of the stretched band is marked; the cord is now detached from the engine, and the last point marked is tied to the lower end of the rubber band, and the cord again secured to the engine just as at first. The apparatus is now ready for use; the detent is thrown in and the engine started. At each revolution the rubber band takes up all the slack and keeps a moderate tension on the cord, and whenever a card is taken or removed, and the detent thrown out or in, the action of the band takes up all sudden shock, and yet is too light to have any effect on the tension of the cord when the detent is out and the barrel spring working. In the illustration the detent is shown in gear and the throw of the indicator motion at its least distance from the indicator.

On locomotives a canvas dust-cover can be used over the indicator, and the apparatus kept in place during a long run without injury, so that a most valuable set of cards may be secured marking the different powers on heavy and light grades and at various speeds.



A DEVICE OF VALUE TO INDICATOR-CARD TAKERS.

For dynamo engines we know of nothing so well suited as is this appliance, and the cost of running these engines may be clearly shown by fair card. Roughly taken cards serve no purpose here, the points of cut-off and the lines of expansion being too indefinite to indicate leaky pistons, a source of loss more frequent in this kind of machinery than any other, and one which counts heavily in the coal bill.

A. A. W.

THE ACCURACY OF VALVE-GEARS.

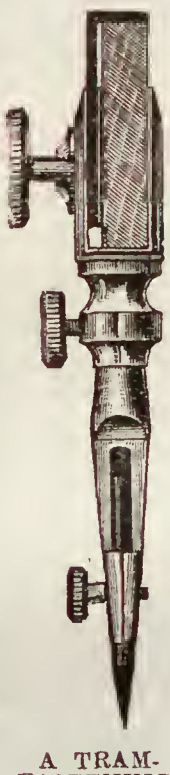
To the Editor of THE AMERICAN ENGINEER:

It is a common remark of inventors and their friends in describing the claims of new valve-gears to say that they are mathematically correct, or that they give an excellent or nearly perfect distribution of steam. Mr. David Joy made such a claim in first describing his radial valve-gear (see Proceedings of the Institute of Mechanical Engineers, 1880, p. 425). He made a similar claim in his recent paper on his new hydrostatic single-eccentric gear before one of the engineering societies, as reported in the technical journals some two years ago. Regarding this later gear of his, he particularly mentioned, as a proof of its excellent accuracy, that the heat of the exhaust was beautifully regular, not at all like the irregular heat characterizing the common double-eccentric and expansion link gear. Alexander Morton, in his paper of 1882 before the Glasgow Society of Engineers, describing his radical gear (p. 8), claims that "*the motion of the slide-valve is mathematically alike in amount.*" Arrol and Pringle, in their British patent, No. 13,710, of November 11, 1885, for a single-eccentric gear, which I have lately been studying, make a similar assertion that their gear is mathematically correct.

Now what do such assertions and claims mean? Any one who has studied valve-gears by Zeuner's polar-circle diagram

and equations, knows well that for all gears controlled by any form of circular motion from the engine driving-shaft, the travel of the slide-valve from its mid-position is a function of the angle of the revolution of the crank—that is to say, neglecting the "*missing quantity*" and errors due to local disturbances of the gear by its various movements, the slide-valve opens, suppresses, exhausts, compresses, and opens again at equal angles on the crank path from either dead point, *not at equal points in the piston-stroke.* From the Zeuner standpoint, therefore, only a crank-path equality of angles can be termed mathematically correct. Of all the various valve gears invented, Arrol and Pringle's single sliding-eccentric gear alone gives an absolutely true polar-circle diagram, every stage of the valve movements being at equal angles on the crank-path from either dead point, and, to use Zeuner's term, there is no "*missing quantity.*"

Designers of valve-gear, however, never desire this sort of regularity. Their aim always is to produce equality of cut-off in the cylinder, tempered with a slight excess on the instroke sufficient to recoup loss of piston-rod area, or in vertical engines a slight excess on the lower side of the piston to partially balance its weight. Owing to the angularity of the connecting-rod the piston always travels farther on the outstroke than on the instroke for the same angle on the crank-path. Hence, any valve-gear deriving its motion from the driving-shaft will give a later cut-off on the outstroke than the instroke, unless it be specially adjusted to avoid this; in other words, to get equal work done on both sides of the piston every endeavor is made to prevent such gears from acting with "*mathematical correctness.*" Designers of locomotive valve-gear, while aiming at tempered equal cut-offs on the stroke, do certainly try to get the exhausts at equal angles on the crank-path, but this is for a wholly different reason—namely, to get a regular beat of the blast, as it is found that an irregular beat does not produce so good a smoke-box vacuum and needlessly tears the fire about. As the crank in a locomotive revolves at a constant speed, it is clear that to get a regular beat exhausts at equal crank-angles are necessary.



A TRAM-FASTENING.

To get the cut-offs equalized and tempered on the two strokes, all sorts of expedients are adopted for "*doctoring*" the gear, advantage being taken of local disturbances in the gear to set one off against the other, so as to produce the desired result. In link-motion work the moral maxim that two wrongs never make a right does not hold good. With this object the position of the reversing-shaft is shifted about, suspension links are made to swing away, eccentric-rods are made of unequal lengths, and unequal angles of advance given to the eccentrics. Probably the easiest and most fruitful doctoring is got by employing a rocking-shaft to drive the valve. By giving it a suitable location, the cut-off can be readily tempered as desired, and with equally good results for both fore and back gear. I am convinced that this useful property of the rocking-shaft explains its universal use on locomotives in America, where with steam-chests on top of the cylinders radial gears have made absolutely no way at all.

During the past quarter of a century I suppose I have read every book published in the English language treating of link-motions and valve-gears generally, and nothing has impressed me more than how that nearly all of them ignore the desirability or necessity for this doctoring of the gear, and devote pages of useless calculations and diagrams to proving the correct position of the reversing-shaft, length of reversing-arms, drag-links, etc. Zeuner set the example of this pernicious theorizing, but the professors generally have run greedily after him. It is safe, however, to say that not a single gear has ever been executed where engineers have adopted the theoretical proportions and locations for the various parts recommended by these excellent people.

On the other hand, I do not say that engineers are necessarily right in their insistence on the need for equalized cut-offs in the cylinder and all the dodging and doctoring of the gear which this entails. None, however, of the professors has had the courage to dispute this Will some of them now consider the matter and inform us exactly what is the gain in efficiency from securing cut-offs in the cylinder equalized on the stroke of the piston rather than on the crank-path? In other words, why should the work done on the two strokes of the piston be equal rather than that done through the two halves of the crank-path?

To clear the ground, I may point out that without the dodging and doctoring referred to, all valve-gears wholly operated by eccentrics or return cranks actuated by the driving-shaft, tend, when laid down in their simplest and most theoretically dictated forms, to give valve movements equalized on the crank-path. All single and double-eccentric link-motion gears come in this class. All radial valve-gears, where the port opening movement is obtained by a return crank or eccentric (such as Von Hensinger's gear, several forms of Morton's gear, and one form of Joy's gear), also tend to give valve movements equalized on the crank-path and form one class with the above. Only those radial gears where the port-opening movement is obtained from the to and fro motion of the cross-head tend (so far as local disturbances of the gear may permit) to give valve movements equalized on the stroke of piston. The marine form of Morton's gear and a few other lesser known gears of similar class fulfil this condition. These forms of radial gear where the port-opening movement is obtained from the to and fro motion of the same point in the connecting-rod, which by its vibratory motion gives the lead of valve (such as Joy's best known form of gear), lie midway in performance between the two classes above named. The nearer the point taken in the connecting-rod is to the cross-head, the nearer they approach the second class, and *vice versa.* Will any of your readers now say which of the two classes undoctored is the better?

In conclusion, while on this subject I may draw attention to the very common, not to say general, assertion (often assumption) made by all sorts of writers, that radial gears are superior to link-motions in giving a later exhaust with less compression. Joy asserted this of his gear, claiming that he could work in marine engines with a single slide-valve only, where before with link-gear a separate expansion valve was necessary (see Proceedings of the Institute of Mechanical Engineers, 1880, p. 428). Such a claim is not according to fact. No greater improvement in that respect is obtainable by employing a radial gear than by employing a link gear properly proportioned and sufficiently doctored. From experiments with full-sized model boards with two different gears operated together, I can assert that for all practical purposes radial gears and link gears, designed for the same engine with same lap and lead, act identically, and the valves operated by both move synchronously. DIGNA SEQUAMUR.

INSEIN, LOWER BURMA, August 1, 1895.

TRAM-FASTENINGS.

Editor AMERICAN ENGINEER:

Noting your remarks on the Alteneder beam-compass in last month's issue, I wish to say that your first views were not far out of the way. The necessity of making a special beam is a nuisance, as it is no easy thing to make a rabbet in a long, thin piece of wood and have it straight. Some years ago I made a little piece of German silver, as per sketch, which avoided this. Several of my friends have adopted this and find it very convenient, as any carpenter can very quickly furnish them with a plain stick. I like Alteneder's work *very* much, particularly his new pen, with which I would not part.

BOSTON, MASS. ALBERT F. HALL.

THE GREAT SIBERIAN RAILROAD.

THE new Russian Minister of Ways of Communication, Prince Khilkov, in the matter of the construction of the Siberian Railroad, evidently will not endorse the acts of his predecessor. The delay in construction of the South Oussouri line, its excessive cost and the uncertainty in the estimates of the Central Siberian Railroad and of new lines, have suggested to him the idea of sending to Siberia a special commission for studying the conditions of the construction of the Siberian Railroad.

In the twenty-second session (March 8/20, 1895) of the Committee of the Siberian Railroad, consolidated by the Department of State Economy of the State Council, and presided over by the Emperor Nicholas, the Minister of Ways of Communication proposed, in order to study the present condition of the works of the Siberian line upon the spot, and its future prospects, to send to Siberia a special temporary commission, presided over by the Vice-Minister, General Petrov, and consisting of seven engineers and four persons of other specialties.

The organization of this temporary commission was approved, and 100,000 roubles were appropriated for its expenses.

At the same session the Minister of Finance brought up the question of a commercial harbor in Vladivostok, and suggested

THE TOBOL BRIDGE AT THE TIME OF TESTING, 1895.

CONSTRUCTION OF THE ISHIM BRIDGE. SINKING OF THE FIRST CAISSON AND THE TEMPORARY BRIDGE.

the necessity of examining the place. For the purpose of this survey and location 20,000 roubles were appropriated.

A credit of 346,200 roubles for the 30 mail cars to be ordered for the Western Siberian and the Central Siberian Railroad (from Chelabinsk to Irkoutsk) was intended.

The twenty-third session of the Committee of the Siberian Railroad, consolidated by the Department of State Economy of the State Council, presided over by the Emperor Nicholas, was occupied with the new rules for facilitating the work of exiles and prisoners on the construction of the Siberian Railroad and the new staff of police in the region of the works of the Oussouri line.

A great many prisoners have already worked on the construction of the Oussouri and Central Siberian lines, and the results obtained on the latter are quite satisfactory. The prisoners worked on the grading on Irkoutsk section (516 men) and on Krasnoïarsk section (435 men), and moved about 5 cub. yds. per day, earning about 50 cents a day.

In the same session (May 3/15, 1895) the instructions to the Commission for studying the construction of the Siberian Railroad were confirmed.

According to these instruction, the Commission—presided over by the Vice-Minister—consists of 13 members: seven from the Ministry of Ways of Communication, two from the State Comptrol, one from the Ministry of Finance, one from the Ministry of Interior, one from the Ministry of Agriculture, and one member—secretary. A supplementary member from the Ministry of War will be appointed by the Chief of Oussouri War District.

The Commission will consider the following questions: (*a*) The present state of the works of construction of the Siberian Railroad; (*b*) the suitableness of the means employed for the construction; (*c*) the future plan for the most successful and profitable mode of construction verified on the spot; (*d*) the possibility of finishing the works in the proposed time; (*e*) the sufficiency of preliminary estimates.

As a technical body, the Commission inspects all the constructions already finished and still in progress—viz., grading, track, bridges, etc., and also the state of the rolling stock.

The financial duty of the Commission consists in studying the means for furnishing the materials, in examining the contracts and the liability of contractors, ascertaining whether money is spent with proper economy, and in the end in ascertaining why the cost of construction of the Oussouri line has surpassed the preliminary estimates.

The Commission, as an administrative body, will have in view the furnishing of workmen for the construction, it will elucidate the question of possibility or necessity of using the strangers and foreigners and the prisoners. It will decide whether the population is sufficient for the future support of the railroad.

Besides these subjects, the Commission will study the waterways in connection with the construction of the Siberian Railroad, and the means for the development of the iron works.

The Commission left St. Petersburg at the end of May and divided into two parties, one of which has gone by land to Irkoutsk, and the other by ocean to Vladivostok. Both parties will meet in Irkoutsk, and will there work on the new estimates of the Central Siberian & Transbaïkal line, and at the end of August will return through Omsk and Chelabinsk to St. Petersburg.

The twenty-fourth session (June 28/ July 10, 1895) of the Committee of the Siberian Railroad, consolidated by the Department of State Economy of the State Council, and presided over by the Emperor Nicholas, was occupied by the appointment of a new staff of police in the region of Transbaïkal Railroad, the organization of the work of prisoners in the Tomsk Government (Central Siberian Railroad), and the question of the harbor of Vladivostok.

The use of prisoners in the construction of the Siberian Railroad has been much increased. At present 1,450 prisoners and exiles work on the North Oussouri line (the extension of the South Oussouri line). Four parties of prisoners, 150 men each, work on the Transbaïkal line.

The use of prisoners has been extended also on the Tomsk Government, and will greatly facilitate the construction of the Central Siberian Railroad.

In the vicinity of the line there are the Nicholas Iron Works, leased by Mr. Glotow, who contracted for that line 1,000,000 poods (16,000 tons) rails, at the price of 2 roubles a pood ($60 a ton). The contractor has also received 300,000 roubles as a government loan for the development of the works.

The Vladivostok harbor will be constructed in the Bay of Golden Corn. Its length will be 1,540 ft., and the depth 26 ft. The general cost is estimated at 500,000 roubles ($250,000).

In the same session—July 10, 1895—the following general data about the state of construction were presented:

The track is already laid on the first division of the Western Siberian Railroad, from Chelabinsk to Omsk (500 miles), and 200 miles on its second division;* 143 miles on the Central Siberian Railroad, 251 on the South Oussouri line, and 10 miles in the North Oussouri line; total, 1,104 miles, or about one-quarter of the whole Siberian Railroad.

The earthworks on the first division of the Western Siberia Railroad are finished; on the second division 88 per cent. is made; on the first division of the Central Siberian Railroad, 52.4 per cent.; on the second division, 5.4 per cent.; on the North Oussouri Railroad, 18.3 per cent.; on the Ekaterinbourg branch, 32 per cent.; and on the Transbaïkal line 240,000 cub. yds. are already in place. The number of workmen was quite sufficient in the summer of 1895—viz., on the Western Siberian and Central Siberian, the Transbaïkal and Oussouri railroads the number of men was: 32,639 engaged on earthworks, 13,080 wheelbarrow men (with horses), 5,851 track-layers, 4,370 carpenters, 4,096 masons, 2,099 smiths, a. s. o.—total, 62,135 workmen. Besides on the Ekaterinbourg branch 8,090 workmen, and in all 70,225 men.

For the construction of the Great Siberian Railroad up to January 1, 85,517,551 roubles have been appropriated, of which 73,437,112 roubles have been expended, leaving 12,080,439 roubles.

The surveys of the Amour line were begun in 1894, and have been continued this year.

The survey of the Amour territory, made in 1894, has shown that this country presents a marshy plateau often inundated. The settlements are very scarce. The surveyor has noted only 15. The places suitable for settlement are the following: (1) between the Shouki and Ouldoura mountains and rivers First Shouki and Small Bira; (2) along the river Great Bira, between Stoïby and Kroutoï Yar; (3) south from the river Ourmi, and westerly from Teklin; and (4) between the Great and Small Chourki mountains. In all these places the soil is fertile, wood is abundant, and water is good.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.

SECOND SERIES.—CHEMICAL METHODS.

XVII.—METHOD OF DETERMINING SPECIFIC GRAVITY OF OILS AND OTHER LIQUIDS.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(*Continued from page* 333.)

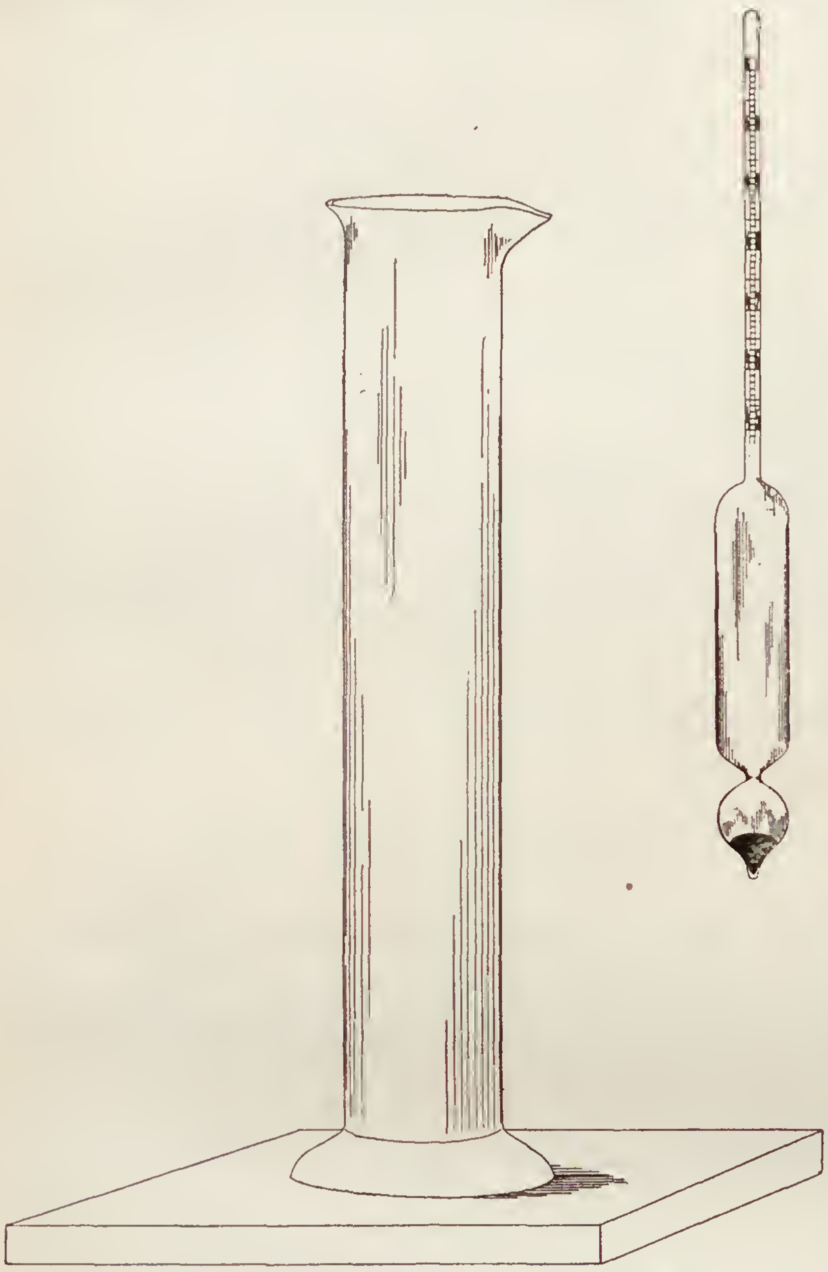
Three different methods are used for determining the specific gravity of oils and other liquids, as follows: I. By means of the hydrometer. II. By means of the Westphal balance. III. By weighing any known volume of the liquid in question, and comparing this weight with the weight of the same volume of water.

OPERATION.

I. When using the hydrometer—applicable to all liquids, whether transparent or not, except such as are too viscous—fill the hydrometer jar to a convenient height with the liquid to be tested, introduce the hydrometer, and alongside of it a delicate thermometer sufficiently long to reach to the bottom of the jar, and be used as a stirring rod. Stir with the thermometer, disregarding the hydrometer for the moment, and taking pains to have the thermometer reach to the bottom of the liquid, until the reading of the thermometer becomes constant. Read the thermometer and withdraw it from the liquid. Raise the hydrometer and wipe the stem clean, nearly down to the bulb, then carefully allow it to sink in the liquid.

* The track is now laid on the whole Western Siberian Railroad.

This operation must be managed so that the stem of the hydrometer will not be wetted above the point corresponding to the gravity of the liquid. Read now the mark on the stem corresponding to the level of the liquid. The reading of the hydrometer is the specific gravity, or the degree of Beaumé's or Twaddle's, or whatever scale the hydrometer is graduated in, corresponding to that temperature, and this reading when corrected for temperature, as provided under "calculations," becomes the reading to be used. The method described above is that applicable to the petroleum products. When other liquids are tested with the hydrometer, if no tables corresponding to those described under "calculations" have been prepared, the temperature must be made 60° F. before reading the hydrometer, and no corrections are necessary.



HYDROMETER AND HYDROMETER JAR.

II. When using the Westphal balance—applicable to all liquids, except such as are too viscous, but works best with transparent liquids—set up the balance on a level place, by placing the beam in position and hanging the plummet on the hook provided for it. Now adjust with the adjusting screw in the foot until the pointers are exactly opposite each other, cool the liquid to be tested to a point a little lower than that at which the balance was graduated, fill the jar with enough of the liquid, to a little more than cover the plummet, and place the jar in position. Allow the temperature of the liquid to raise with occasional stirring, until the reading of the thermometer in the plummet is that at which the balance was graduated. Now hang the weights on the beam at the notches provided for them, until the pointers are again exactly opposite each other. If two belong on the same notch, hang the second on the hook of the first. Read the marks on the beam where the weights hang, and set down the figures by the side of each other, putting the figure under the heaviest weight at the left hand, that under the next heaviest, next, and so on. The result will be the specific gravity expressed in decimals when the liquid is lighter than water. For liquids heavier than water it will be found that one of the heaviest weights will hang on the hook along with the plummet, the others being distributed along the beam. The reading of the heaviest weight will then be 1, which must be followed by a decimal point, the other readings following the order of the size of the weights, as above described, being placed after this decimal point. In case the specific gravity of the liquid in question is 2 or above, or 3 or above, two or three of the heaviest weights, as the case may be, will hang on the hook, the others being distributed along the beam. When the liquid to be tested is opaque, so that the reading of the thermometer in the plummet cannot be made, it is essential to have an additional thermometer to use in determining the temperature. This additional thermometer should, of course, be compared with the one in the plummet.

III. When weighing a known volume of the liquid and comparing it with the weight of the same volume of water—applicable to all liquids—weigh any convenient graduated vessel with a thermometer in it, cool the liquid to be tested to a temperature a little below 60° F., pour into the weighed graduate any convenient measurable amount and weigh. Clean the graduate and repeat the operation with distilled water, using the same volume as before. The ratio of the two weights, using the weight of the water as divisor, is the specific gravity of the liquid.

APPARATUS AND REAGENTS.

The cut shows the hydrometer and hydrometer jar with perhaps sufficient clearness, so that further explanations are unnecessary. The hydrometers usually used with oils are graduated with Beaumé's scale, although they may readily be obtained in the market, with Beaumé's and specific gravity scales on the same instrument. For use with oils they should be graduated to a tenth of a degree Beaumé. There is some difficulty in reading hydrometers, especially with opaque liquids, due to the semi-meniscus of the liquid adhering to the stem. When the hydrometer is graduated to tenths of a degree, it is probable the reading may be in error a corresponding amount. If greater accuracy is desired, hydrometers with much finer graduations must be used, or one of the other methods employed.

The Westphal balance is usually now constructed with a plummet weighing 5 grams, and occupying the space of 5 cub. centimetres. These are called Reinman's. The beam is graduated into 10 equal divisions, and the heaviest weight weighs 5 grams. The next size weight weighs a tenth of this, the next, a hundredth, and the smallest a thousandth. The balance being adjusted in air, so that the pointers are exactly opposite, if the plummet is immersed in distilled water at 15° C., the heaviest weight being placed on the hook with the plummet should bring the pointers opposite each other again.

The choice of a vessel to be used in weighing equal volumes of any liquid to be tested and water depends on the balance used. If a delicate chemist's balance is employed, a small flask with mark on it is applicable. If a coarser balance is used, a larger vessel should be employed. Specific gravity bottles, both with and without thermometers, and appliances for securing equal volumes of the liquid to be tested and water, may be obtained in the market. When the method is used with moderately viscous liquids, care should be taken not to use apparatus with too small a neck, on account of difficulty in filling, and in view of the difficulty of accurately measuring viscous opaque liquids, it is advisable to employ as large volumes of liquid as the balance will allow.

CALCULATIONS.

When the hydrometer is used in oils, unless the temperature happens to be 60° F., a correction must be made. It is generally agreed that for this purpose Tagliabue's "Manual for Inspectors of Coal Oil" shall be used. This manual shows in tabular form for every degree of Beaumé's scale, for liquids lighter than water, from 20 to 100, and for every degree of temperature from 20° to 109° F. the corrected gravity. It has also a comparison of Beaumé's scale with the specific gravity, both for liquids lighter and heavier than water. The method of using the tables is given in the manual. When using the Westphal balance, the readings are obtained direct, and no calculations or corrections are needed. The method of getting the gravity when weighing equal volumes of the liquid to be tested and water is given under "operation."

NOTES AND PRECAUTIONS.

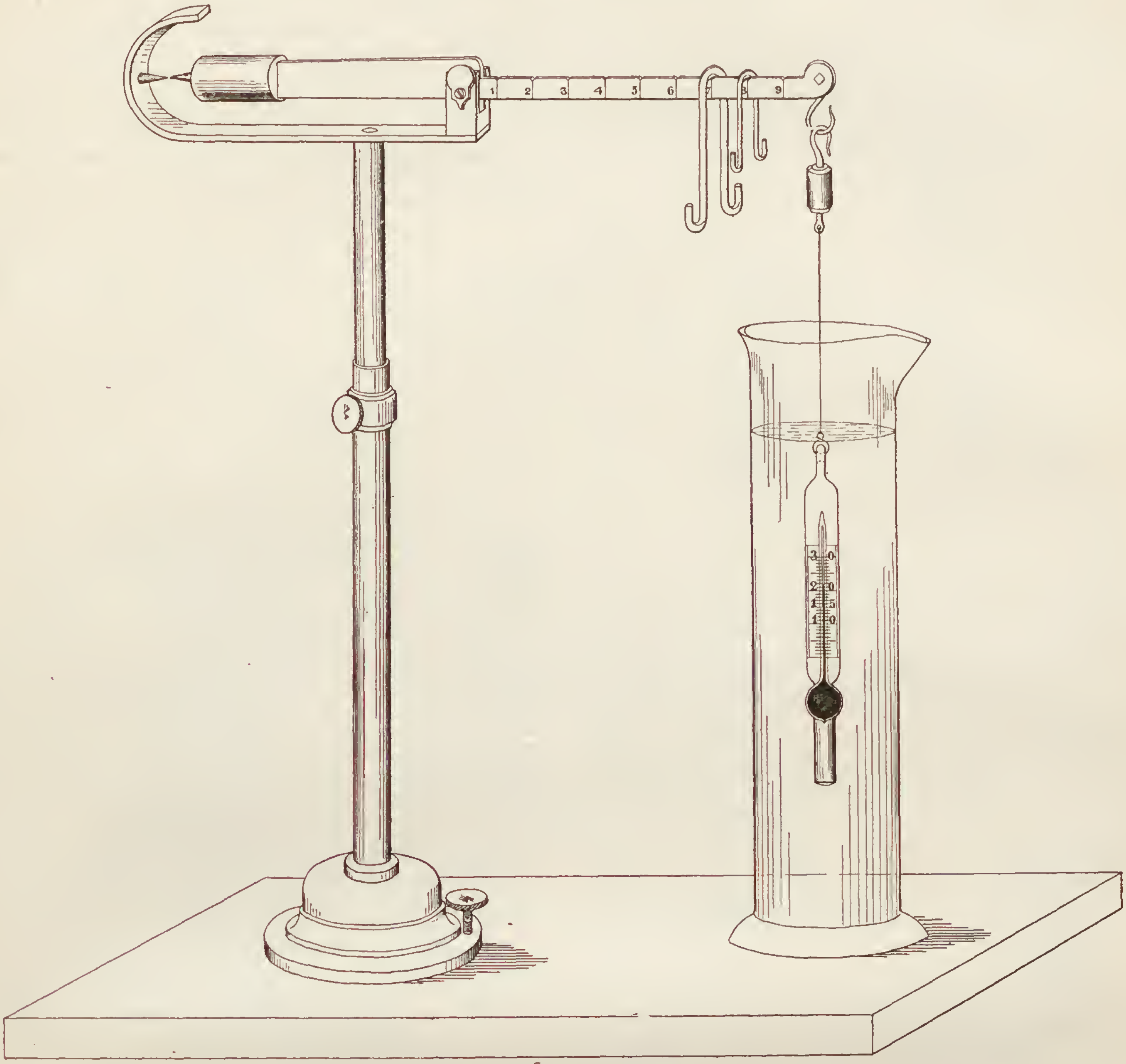
The principles involved in the methods of determining specific gravity, described above, are perhaps too well known to need comment or explanation.

The hydrometer is principally used with petroleum products, the Westphal balance with spirits of turpentine and other transparent liquids, and the method of weighing equal volumes of the liquid to be tested and water with liquids that are too viscous for the other two methods. The Westphal balance is also useful in taking the gravity of standard

solutions and acids, and sometimes when a vegetable or animal oil is suspected of adulteration.

With all liquids which are transferred from one vessel to another, there is always possibility of air being mechanically carried along with the liquid. Usually with petroleum products there is very little difficulty from this cause, since the

It is assumed in the methods described above that the hydrometers are made so as to be accurate at 60° F., whether used in water or other liquids, that the Westphal balance under the same conditions is accurate at 15° C., and that when the liquid to be tested and water are weighed, they are both weighed at 60° F.



THE WESTPHAL BALANCE.

air escapes readily from those which are sufficiently limpid. Petroleum products which are viscous must be warmed or heated sufficiently to allow the air to escape, whichever of the three methods of determining the gravity is employed, and of course when the Westphal balance or the weighing method is used they must be cooled again before the gravity is taken. The temperature should not, however, reach the vaporizing point of the oil. With transparent liquids, when the bubbles of air can be seen, especially if they adhere to the sides of the jar, slow stirring frequently serves to remove them. Allowing the liquid to stand quietly for some time in the hydrometer jar also serves to free the liquid from bubbles. Of course neither the hydrometer or the plummet of the Westphal balance should be introduced into the liquid until the bubbles of air have escaped or been removed, on account of the danger of some of the bubbles adhering to them, and thus leading to erroneous results. Of course also the weighing method gives erroneous results if any bubbles of air are in either liquid when they are weighed. In testing commercial products to which only these methods are supposed to be applicable, no attempt is made to remove dissolved air or other gases.

There does not seem to be universal agreement as to the temperature at which the weight of the water used as divisor should be taken. Some authorities think the weight of water employed should be that at its maximum density, others that at 60° F.

Many of the hydrometers in the market are carelessly made. It is not rare to find them 1° or even 2° Beaumé in error. All hydrometers before use should either be checked in accordance with the principles of their construction or compared with reliable standard hydrometers.

AN EXAMPLE OF WHEEL CONSTRUCTION.

Designed by E. S. Cobb, M.E., San Francisco.

One would suppose, from the universal use of wheels of all kinds, and the careful attention that has been given to the properties and disposition of materials in their construction, that the art had reached the ultimate, but some study of the example here given will, if we mistake not, disclose new features of interest.

The failure of large wheels during five years past forms a long list of serious casualties, showing that the increased rate of rotation demanded in modern practice has not been met by the conditions of construction. At the same time every one knows that the physical properties of common material provides strength far in excess of any demands that working conditions should impose.

Mr. E. S. Cobb, of San Francisco, was called upon some time ago to design a large tangential wheel, 17 ft. 4 in. in diameter, with a limit of weight and cost, and a guarantee of strength and stability, that led him to consider carefully the various methods of constructing large wheels, with the result that he has produced a structure in which all the strains are tensile, and all simple in respect to each member, so the whole value of the material is utilized in resistance to centrifugal and driving forces, and bending strains are eliminated. At the same time the sections throughout correspond to those in common use, rolled from fibrous iron or steel.

The rim sections, seen in figs. 2 and 3, are composed of four angle-iron bars, a radial centre plate, and a covering band, but these can be modified in various ways to receive toothed segments, rope grooves, or a fly-wheel rim. The present design, for which dimensions are given further on, is for a driving band-wheel.

Mr. Cobb sends the following particulars of the wheel shown in the drawings:

FLY WHEEL FOR AN ENGINE 400 to 500 H.P.

Diameter over all	18 ft. 2½ in.
Width of face	30 in.
Diameter of shaft	10 in.
Length of hub, bore	22 in.
" " " over all	32 in.
Center to centre of spokes laterally at the hub	26 in.
" " " " truss rods at the hub	32 in.
Diameter of radial spokes	1½ in.
" " truss rods	2 in.
Weight of rims	11,500 lbs.
" " spokes	2,000 lbs.
" " hub	3,300 lbs.
Total weight of wheel	16,800 lbs.
Weight of rim per ft	210 lbs.
Radius of rim, average	8.58 ft.

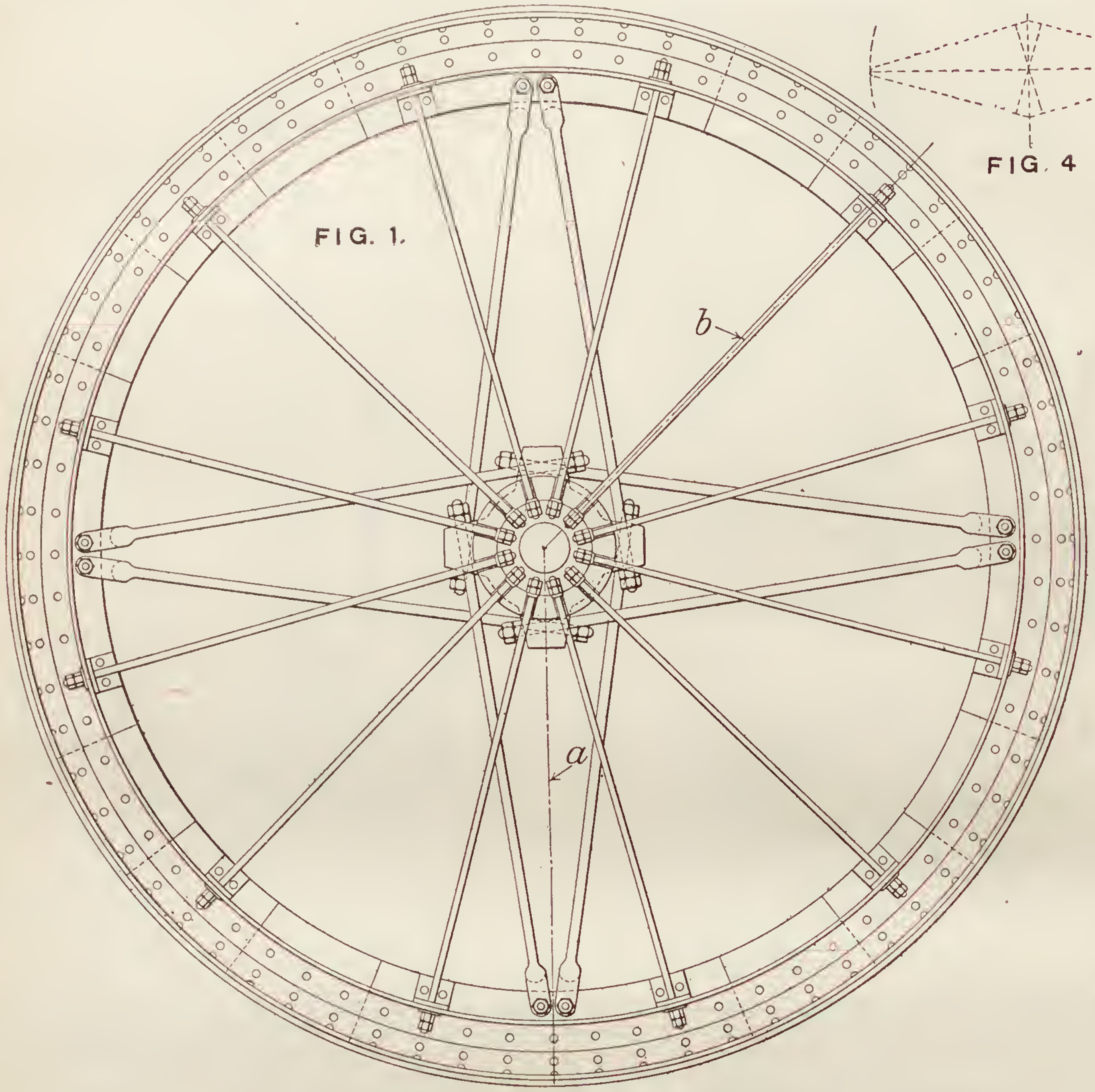


FIG. 1.

FIG. 4

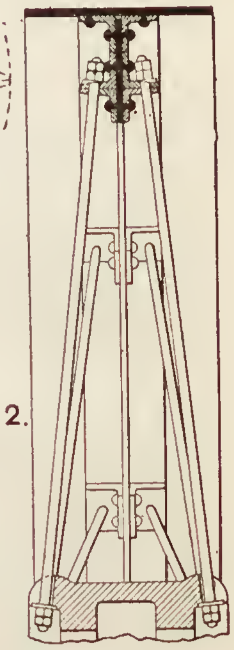


FIG. 2.

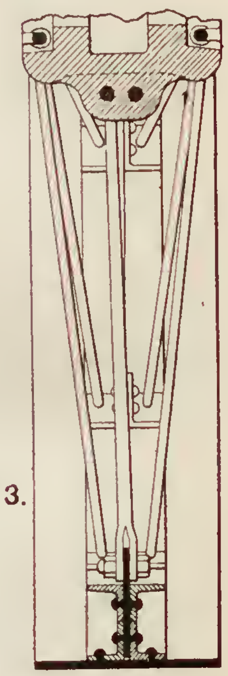


FIG. 3.

FLY-WHEEL FOR 500 H.P. ENGINE, DESIGNED BY MR. E. S. COBB.

By examining the disposition of the various members it will be seen that when the wheel is in motion, all of its members are in tension, except one chord of the driving trusses, of which there are two.

The radial rim-supporting spokes have no function except to sustain the rim and resist centrifugal strain. These spokes are made adjustable, so as to set the rim true and concentric, and are removable separately without disturbing other members.

The turning strain on the driving truss-rods will be understood by the diagram fig. 4, showing the lines of force, the disposition of the parts constituting a symmetrical beam to resist or impart strain about its axis, or to the shaft on which the wheel is mounted. The provision for lateral stability is ample, as will be seen in the sections. Fig. 2 is taken on the line *b*, and fig. 3 on the line *a* of fig. 1.

It will also be seen that this construction affords convenient means of adjusting the rim laterally, also for rotundity, and setting it concentric with the axis or shaft.

At 120 revolutions per minute the whole of the centrifugal force could be sustained by the radial spokes, 24 in number, with a tensile stress of 11,130 lbs. per inch of section. The rim taken at 75 per cent. of its actual section when sustaining the whole centrifugal strain at the same speed would only be subjected to 1,244 lbs. per inch of section, and these two members combined, made of merchantable steel, will show a resisting value up to a rim velocity exceeding 30,000 ft. per minute, far beyond any possible condition of use, or even of accident.

There is also furnished some computed data respecting cast-iron wheels for comparison. This we omit, believing there is no *known* value for cast material in wheels. We have only what is derived from observed results, and calculated values are of little use.

Mr. Cobb is arranging tables of reference for the various components in wheels of this kind, and is prepared to furnish designs, weights, and estimates for wheels of all sizes and strength based upon the methods of construction that have been described.

THE LAVAL STEAM TURBINE.*

By M. K. Sosnowski.

(*Continued from page* 407.)

INSTEAD of utilizing the pressure of the steam M. de Laval conceived the idea, which is far in advance of the other solutions that we have just pointed out, of allowing the steam to expand and thus acquire a velocity that is dependent upon the pressure of the medium in which it acts, and then of utilizing this kinetic energy in a mechanism similar to hydraulic turbines, by communicating thereto a certain amount of its motion by a continuous modification of the direction of the relative velocity and a gradual reduction of the absolute velocity.

THE PRINCIPLE OF THE LAVAL TURBINE.

The fundamental principle of this turbine is that high-pressure steam is entirely expanded when it strikes the wings of the driving-wheel. This expansion takes place in distributers, and the steam therein acquires an active force which is equal to the work that it would have performed while slowly expanding behind a piston. This active force is alone utilized in this machine. Now, the density of the expanded fluid being very low, the principal factor of this active force or *vis viva* is velocity.

Steam under a pressure flowing into the air from an orifice of small section acquires a considerable velocity, which may

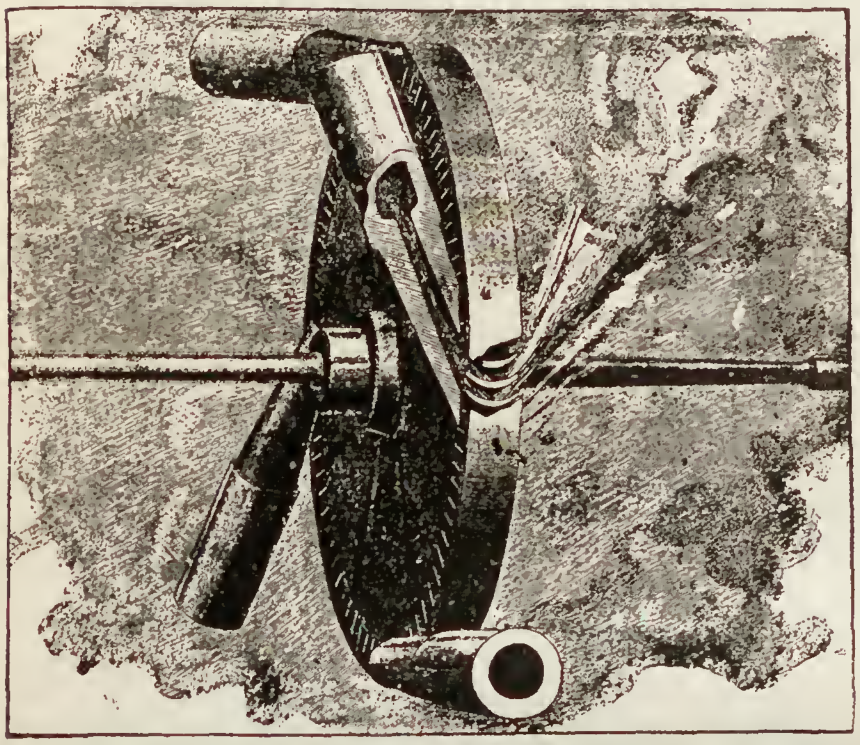


Fig. 14.—PERSPECTIVE VIEW OF THE TURBINE WITH BUCKETS SHOWING THE PASSAGES FOR THE ADMISSION OF STEAM.

even be as high as 2,400 ft. per second at a pressure of 60 lbs. per square inch in the boiler, and 2,925 ft. when the pressure is 150 lbs. If the pressure of the medium into which the escape takes place does not exceed 1.5 lbs., these velocities rise to 3,510 ft. and 3,900 ft. respectively. The velocity of the steam as it leaves the distributers thus being enormous, the same condition must obtain with the rotative speed of the wheel which turns at the rate of from 8,000 to 30,000 revolutions per minute, with a linear velocity that varies from 575 to 1,300 ft. per second.

A great deal of work can thus be communicated to the shaft of a wheel whose details are small. In fact, the tangential strain is insignificant upon a circumference of $2\frac{3}{8}$ in. radius; at 400 revolutions per second it does not exceed 5,600 lbs. per square inch when the machine is producing 10 H.P.; hence, these turbines are very small as compared with the power that they develop (about 19.7 in. for 200 H.P.), and the shafts are light.

DESCRIPTION OF THE LAVAL TURBINE.

The Laval turbine is similar to the hydraulic turbine in the partial introduction and free escape. It is composed of a wheel with wings or buckets (fig. 14), against which the perfectly expanded steam is led by one or more conical openings, whose axis is slightly inclined to the plane of the wheel. These jets of steam enter the conduits and glide over the wings by virtue of the relative velocity and communicate to the latter the *vis viva* of the steam. This steam passes out at the opposite side with an absolute velocity which it is sought to render as low as possible by giving the best possible contour to the wings.

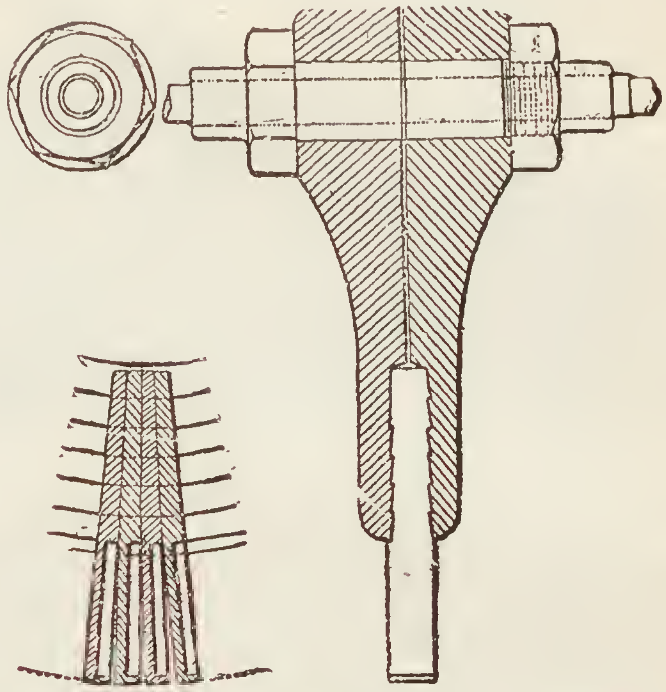


Fig. 15.—TURBINE WITH SEPARATE BUCKETS.

The body of the turbine is mounted upon a steel shaft (fig. 16) which rests in two boxes at its ends, and the whole turns in a chamber (fig. 17), which is provided with the openings *a* into which the outlet for the distributers is fastened. At one end of the shaft there is a regulator (fig. 18), the details of which are shown in fig. 19, that acts by means of a lever upon a balanced safety-valve, placed at the point where the steam enters the turbine. A train of gears (3 on fig. 16 and fig. 20) completes the make-up of the motor, and reduces the speed of the turbine in such a ratio as may be desired.

The Steam Distributers.—This important part causes the steam to be perfectly expanded before it reaches the wings.

Fig. 16.—PINION, SHAFT AND TURBINE.

Its section is of such a shape that the velocity of the jet is increased as much as possible. The final section should be such that the fluid shall have acquired a density corresponding to the medium in which the turbine is working. These openings can be controlled by means of butterfly valves which are placed in the steam passages; so that it is readily understood that by this means the power can be easily regulated, since each opening may be made to act practically independently, and the efficiency be kept at a high point.

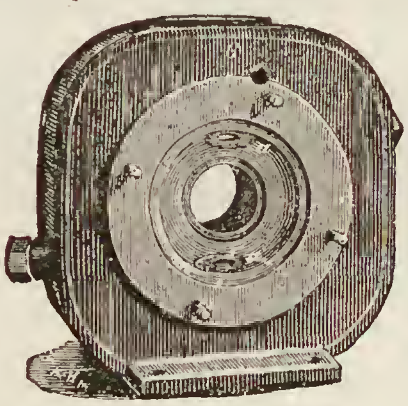


Fig. 17.—THE CHAMBER.

The Wheel Proper.—The wheel of the turbine is made of steel of the very best quality; the wings are cut from the solid metal on the periphery, and a band of steel is then forced on over the tubes (fig. 14). This band prevents the escape of steam from the ends of the wings; it also does away with the prejudicial resistance that would otherwise be set up between the surrounding atmosphere which is at rest. These wings can also be made separately, and then put together, as shown in fig. 15.

The Flexible Shaft (4, fig. 16).—It is a certain thing that whatever precautions may be taken in the making of the wheel, it is almost impossible to produce one wherein the centre of gravity shall coincide with the geometrical axis of

* Paper read before the Society of Civil Engineers of France.

the shaft and at the same time have its plane of symmetry perpendicular thereto.

As the wheel has a high angular velocity, the effect of the centrifugal force would become considerable. For each ounce placed on the periphery of a wheel 7 in. in diameter and making 24,000 revolutions per minute, the centrifugal force amounts to 140 lbs., the principal effect of which with

FIG. 18.—THE REGULATOR.

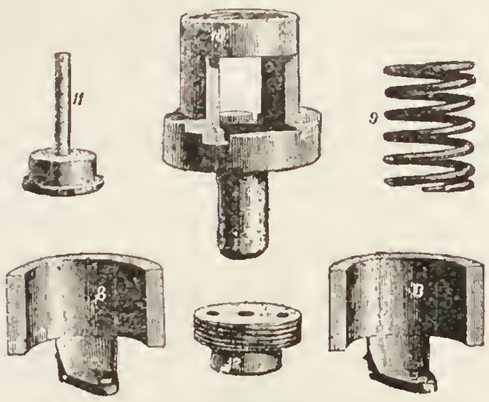


FIG. 19.—DETAILS OF THE REGULATOR.

rigid shafts would be heating in the bearings and a breakage of the shaft. M. de Laval has overcome this difficulty in a very ingenious manner and with entire success, by utilizing the gyrostatic properties of bodies and by mounting his wheel in a certain way upon a very small, and consequently very flexible shaft.

If a body which is symmetrical about an axis held at its extremities and passing through the centre of gravity is made to revolve, it will tend, as its velocity is increased, to turn about its axis of principal inertia, which is the line perpendicular to the plane and passing through the centre of gravity. The physical axis being flexible will take on the deformation necessary to permit of this adjustment, as shown in fig. 23. The position of the disk which, for the sake of simplicity, we have taken as an example, is a matter of no moment. This disk may be at the centre of the axis, as in fig. 23, at a distance of one-third from one end, as in fig. 24, or one-quarter, as in fig. 25. The vibratory motion of the shaft alone will be changed. If, on the other hand, we cause a disk to turn about a flexible shaft that is at right angles to its plane of symmetry, but does not pass through the centre of gravity, we will have two different cases:

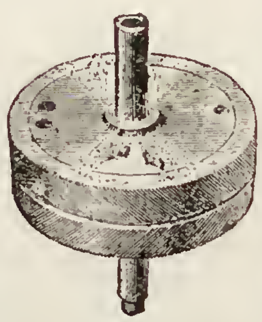


FIG. 20.—THE GEAR.

1. The disk being placed in the centre of the shaft between the two fixed points, the centre of gravity will tend to move out as far as possible, and this tendency will increase as the speed increases (fig. 26, a' a'').

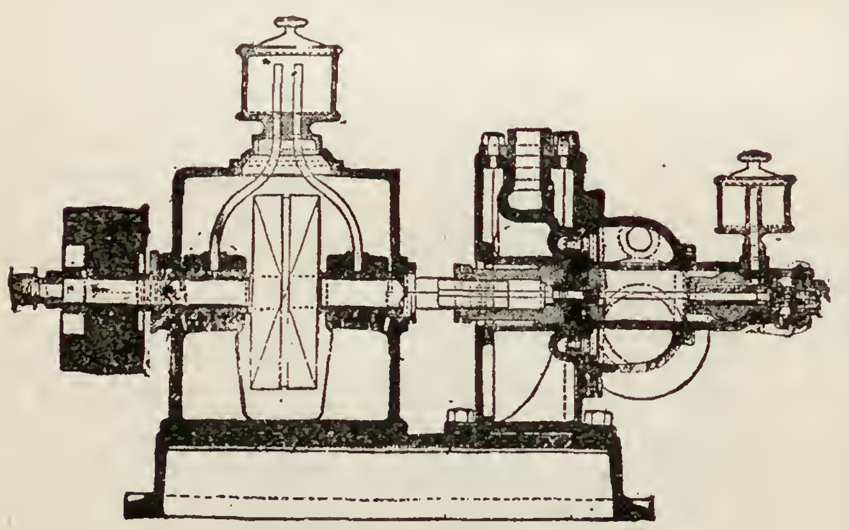


FIG. 21.—LONGITUDINAL SECTION OF THE TURBINE.

2 If the disk is not at the centre of the shaft, the latter will commence by bending; but then the plane of symmetry of the disk will become inclined to the geometrical axis, and, as the speed increases, will tend to adjust itself perpendicularly to this axis, and thus bring the shaft back into true alignment with its bearings.

In point of fact, the shafts of the Laval turbines are made of steel of very small diameters; the bearings are very long; they rest in bronze boxes with linings of anti-friction metal, with a moderate but continuous amount of lubrication, so that all binding is avoided.

Regulation of Speed.—The several pieces of the regulator are shown in fig. 19. Their operation is as follows: The bases of the regulator formed by the two half cylinders (8) are pivoted upon the shell (10), and the lugs that serve as the base for these half cylinders rest against the head of a point (11)

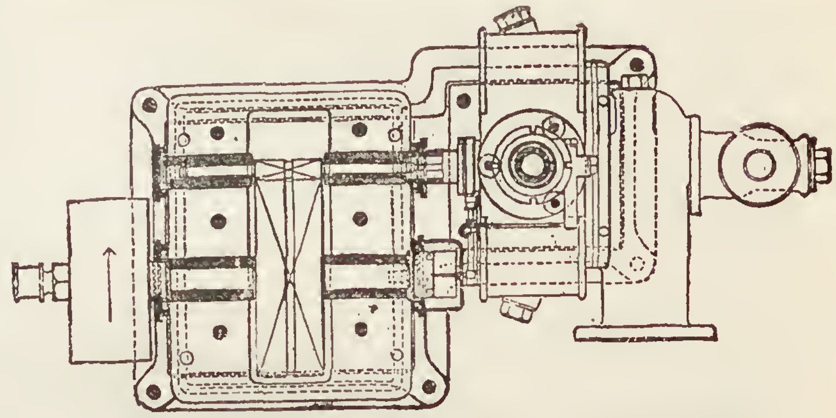


FIG. 22.—HORIZONTAL SECTION OF THE TURBINE.

that acts through a lever upon the admission valve. The point (11) is held by a resisting spring (9) inclosed in the shell by means of a screw (12). The regulator acts upon the admission valve and insures a perfect regulation of the machine regardless of the load.

Furthermore, the steam on leaving this valve is divided so as to pass through several conduits, 4, 6, 8, according to the machines. The valves can be operated from the outside of the machine by means of hand valves which permit the maximum power of the machine to be reduced by a half, a third, a quarter, etc., while the excellent conditions of economical action

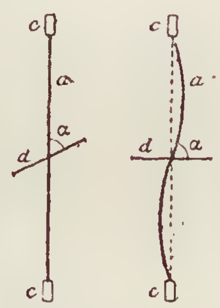


FIG. 23.

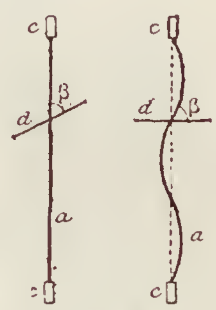


FIG. 24.

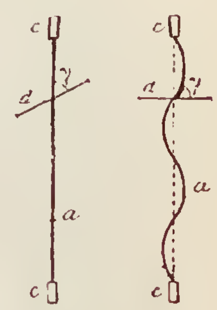


FIG. 25.

are still preserved. The result is that a given machine consumes about the same amount of steam per H.P. when working at one-half, a third, or a quarter of its normal power.

APPLICATIONS.

Motors.—The Laval turbine can be used to replace ordinary steam-engines in all of their applications. Fig. 28 represents the whole of a motor of from 5 to 50 H.P. Starting from this size, the turbines have twin motor shafts, and consequently two controlling pulleys. The speed of the turbine always being very great relatively to the machine to be driven, all of the machines are provided with an auxiliary shaft that is connected to the main shaft by means of a pinion (fig. 16) and a gear (fig. 20).

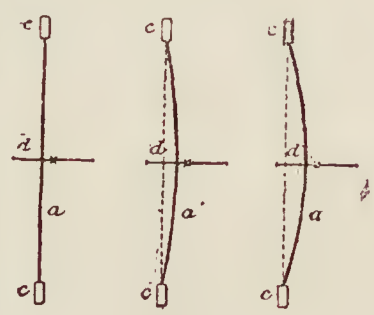


FIG. 26.

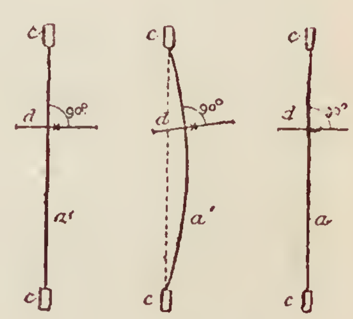


FIG. 27.

Figs. 21 and 22 represent two sections of turbines. Fig. 32 shows a practical application; the speed of the driven shaft is 480, while that of the pulley on the turbine is 3,000 revolutions per minute.

Fig. 33 illustrates a motor with twin shafts, such as is used on turbines of more than 50 H.P. This turbine has two grooved pulleys for a rope transmission. The cable is kept taut by a special idler shown in the engraving.

Dynamo Turbines.—When a dynamo is to be driven by a turbine we can couple them direct. Figs. 29 and 30 show some simple generators that are coupled in that way. Fig. 31 represents a turbine dynamo with two shafts, as indicated for

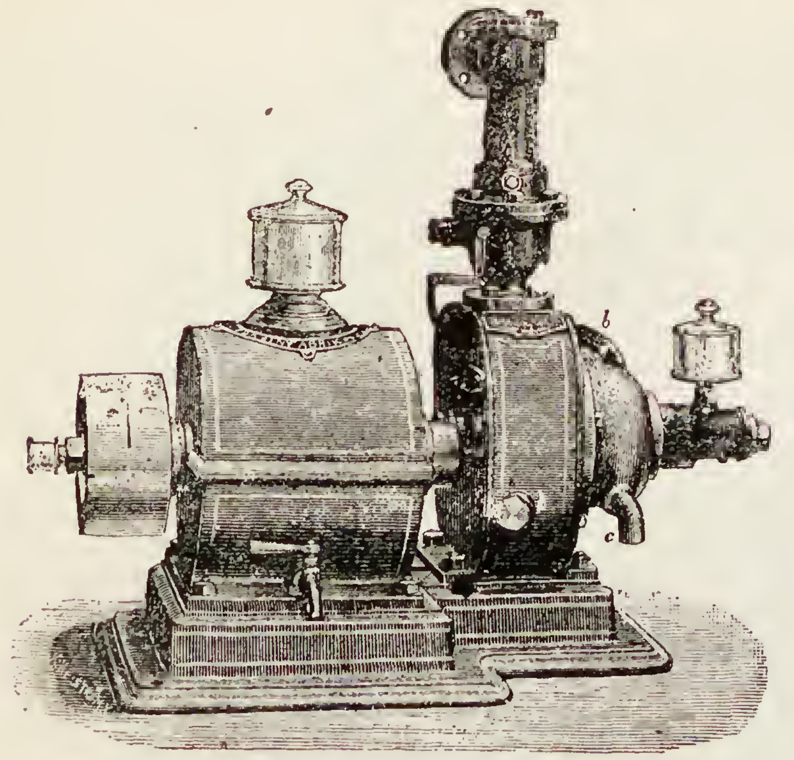


FIG. 28.—VIEW OF THE TURBINE MOTOR COMPLETE.

a three-wire system. Fig. 34 shows a complete electrical installation.

Turbine Pumps and Ventilators are further applications of

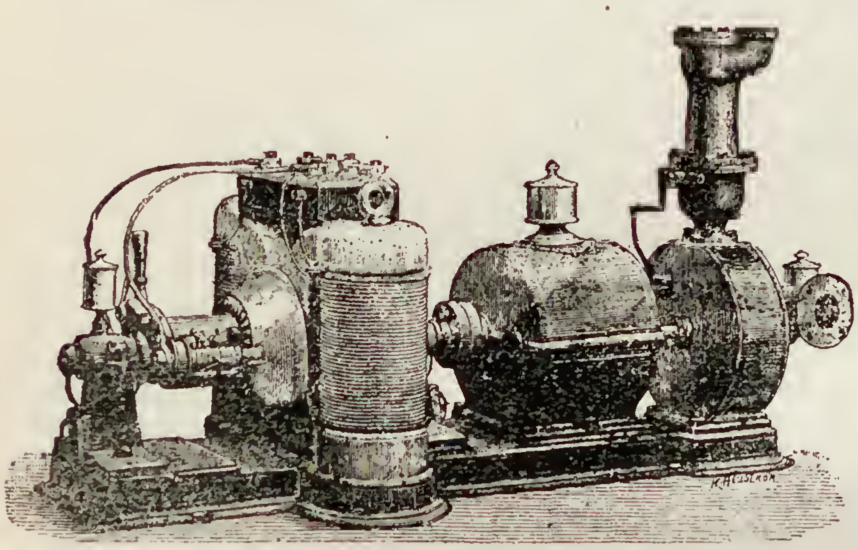


FIG. 29.—VIEW OF TURBINE COUPLED TO A DYNAMO.

the turbine. Fig. 35 shows a simple turbine pump. Fig. 36 is a compound turbine pump. Each of the two driving-shafts of the turbine are coupled to a centrifugal pump. They are

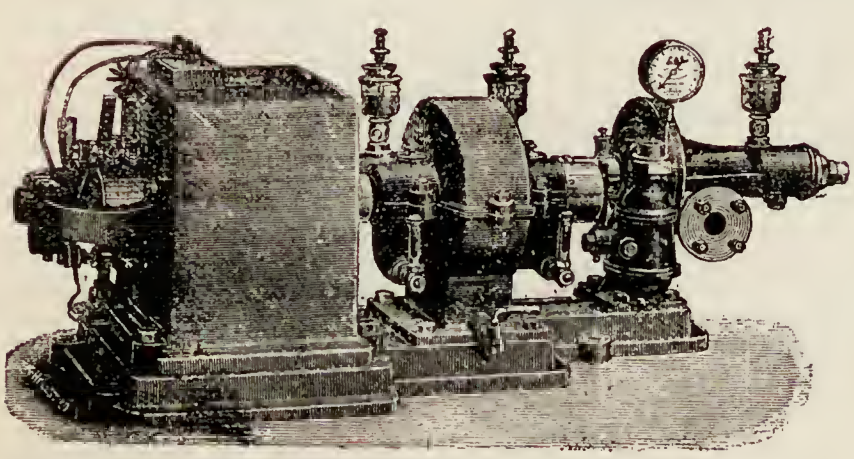


FIG. 30.—A DYNAMO TURBINE.

connected together in parallel to double the output, or in series to increase the pressure of the liquid as it is delivered.

ADVANTAGES OF THE LAVAL TURBINE.

1. In all rotating machines working at high speeds the wear of the parts subjected to frictional contact soon produces a play between these parts. Tightness being an absolute condition of economy for all of these machines, and as this tight-

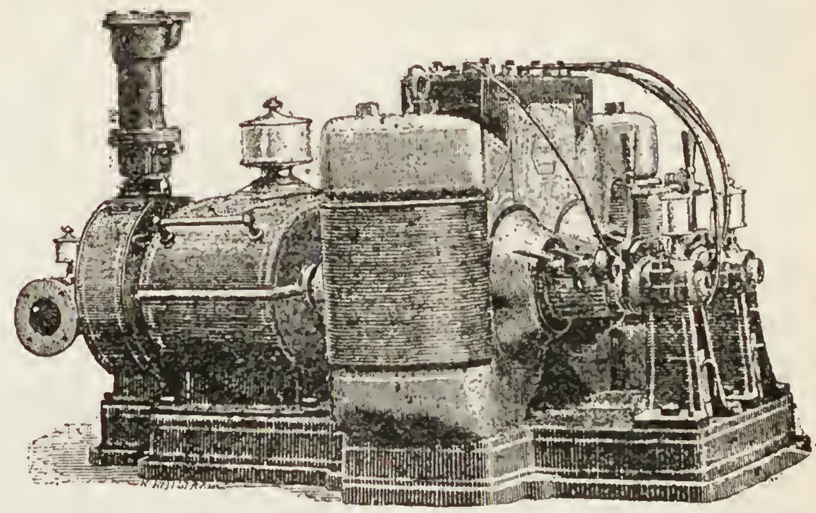


FIG 31.—A DYNAMO TURBINE WITH TWO SHAFTS.

ness soon disappears, the consumption of steam which, at the start, sometimes remains below 60 or 70 lbs. per H.P., soon rises to enormous proportions.

In the Laval turbines, on the other hand, the *vis viva* of the steam being the active agent, and not its pressure, there is always a play of .1 in. left between the wheel and the casing, so that no part is subjected to any frictional contact, and the consumption of steam remains practically constant, however long a time the apparatus may have been at work.

2. In principle the steam is of the same pressure upon both sides of the wheel. It therefore quite naturally follows the path which the passages through the wings offer to it, if these latter have the proper contour, and the direct passage to the exhaust is evidently *nil* as well at the time of the delivery of the machine as after it has been running for a time.

This claim has been substantiated in practice. In fact, it is sufficient to open one of the drips in the motor casing on the exhaust side to show that the steam has no velocity when it leaves, and that is the reason why, as we have just said, the inventor leaves a very perceptible play between the wheel and the casing, in order to do away with all frictional resistances upon the periphery of the wheel.

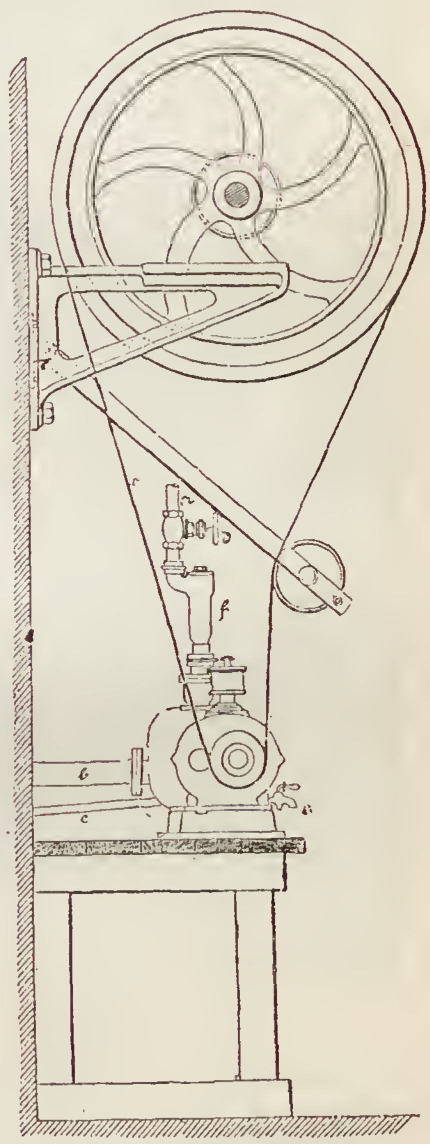


FIG. 32.—*a*, ADMISSION ; *b*, EXHAUST ; *c*, DRIP FOR WATER OF CONDENSATION ; *d*, THROTTLE-VALVE ; *e*, COCK FOR OIL DRIP ; *f*, SEPARATOR-BOX.

3. Condensation in the machine can be neglected, whatever may be the pressure of the steam that is used. In fact, the steam is brought by its passage through the conduits down to exhaust pressure at the moment when it comes in contact with the wheel. High-pressure steam, and consequently steam at a high pressure, never comes in contact with the wheel, which does not, therefore, have to be subjected, like the cylinders of a piston engine, to those alternating high and low temperatures which are the main cause of condensation. The conduits can, furthermore, be entirely protected from the cooling action of the air, and this is the case with the Laval turbine where the conduits are absolutely protected by considerable thicknesses of metal.

4. The utilization of the steam is pushed to the last available limit, since in passing through the conduits it drops from the pressure existing in the boiler to that of the atmosphere. The result is that this machine shows an economy of consumption equal to that of the best steam-engines.

M. Coderblom, Professor at the Central School of Stockholm, M. Anderson, his assistant, and M. Uhr, Inspector of Measures, made a test of these machines while running condensing, and found that they showed a consumption of 19.8 lbs. of steam per effective H.P. per hour, with an admission pressure of 52 lbs. per square inch, and a vacuum of 26.4 in. We have had occasion to repeat these same tests several times, and have thus checked off the accuracy of these figures.

5. The Laval turbine consists practically of a single moving part, which is formed of a wheel turning freely in a steam-chamber and a train of gearing. There are no piston, connecting-rod, boxes at each end of connecting-rod, no valves or eccentrics, as we have seen from the engravings.

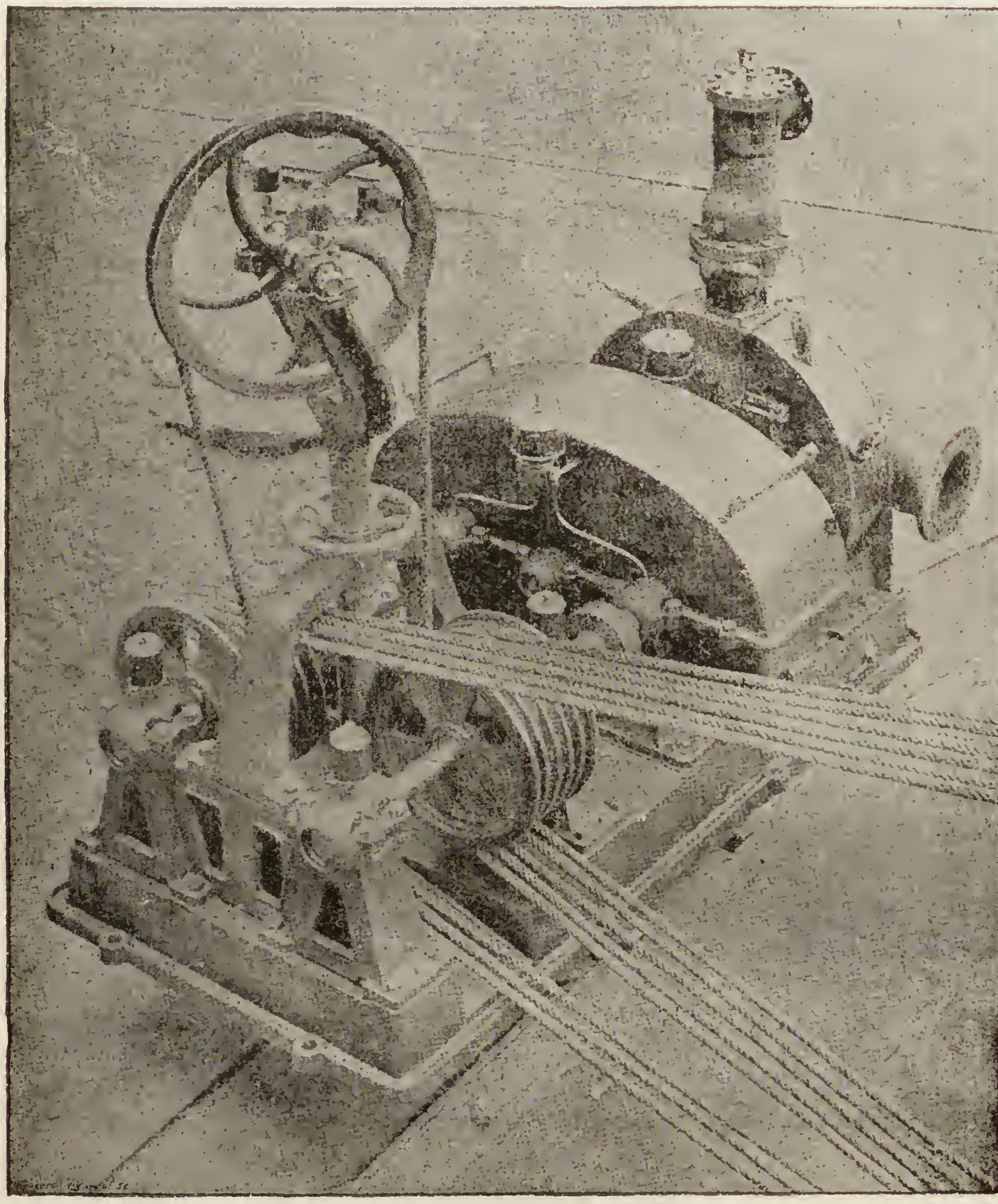


Fig. 33.—A TURBINE WITH TWO GROOVED PULLEYS FOR ROPE TRANSMISSION.

Finally, there are numerous advantages connected with the Laval turbine: great simplicity of construction; low passive resistances; no foundations; greatly reduced number of attachments; light weight; very uniform speed; low steam consumption; reduced cost for oil and packing; no constant attention required; easily taken down and inspected; silent running, and freedom from vibrations.

Thus the weight of the turbine can be scheduled:

For	5 H.P.	it weighs only	286 lbs.,	or	57.2	lbs.	per H.P.
"	10 "	" "	440 "	"	44.0	"	" "
"	15 "	" "	517 "	"	34.46	"	" "
"	30 "	" "	902 "	"	30.06	"	" "

All of these advantages have, furthermore, been established by a service of three years; about 6,000 H.P. had been put in service on January 1, 1895, in France and abroad, and everywhere their operation has left nothing to be desired.

CO-OPERATION.

Two movements which are reported in the London papers seem to be worthy of more than a passing notice. One was the meeting of the first International Co-operative Congress, and the other the opening of the ninth annual exhibition of the products of co-operative workshops. This exhibition is promoted by the Labor Association, a body which seeks to extend co-operative production based on the co-partnership of the workers. The success of co-operation for the distribution of commodities in Great Britain through the co-operative stores has been so great, that there is no longer any doubt as to the possibility or practicability of conducting business on a large scale on that system.

According to a statement issued by the Labor Association, the co-operative movement so far has been chiefly successful in storekeeping. "A marvellous plant has grown from the seed planted by the Rochdale Pioneers Society, when in 1844 they opened a co-operative store for the sale of goods to members on the basis of dividing the profits among the customers in proportion to their purchases. In Rochdale the co-operative method has so far supplanted private trade that there are now in the town three co-operative stores. In 1894 the societies had 18,785 members, holding a share and loan capital of £457,871, doing an annual trade of £391,080, at a profit for the year of £53,303." Spreading beyond Rochdale, up and down the country, the store movement has grown to very large proportions.

In opening a discussion of this subject the chairman, Mr. Frank Hardem, of the International Committee of the Co-operative Union of Great Britain, said that "in the distributive stores movement members must be shareholders, or they could not reap all the advantages. The system was a marvel of organization. Among the industrial organizations that had found their origin in the nineteenth century none had been such a power for good as the co-operative stores, which were some of the strongest examples of thrift, industry, and self-help. The wonderful growth of the movement was shown by the fact that the number of societies was now 1,674, with a membership of 1,343,518, a share and loan capital of £18,500,000, a reserve fund of £826,872, and an invested capital of £7,780,000, while the sales in 1894 realized £50,000,000, and secured a profit of no less than £5,000,000."

The success of co-operation for production has not been so great—in fact, to a very considerable extent its history has been one of failure and not of success. When, therefore, a small body of men who still maintain their faith in the possibility of co-operative production, and undertake to show what measure of success they have met with, their report is at least a very interesting one to all who hope for an improvement in the relations of employers and employed, and in the condition of both.

In a statement issued by the Labor Association, co-partnership is explained to be the equal partnership of labor with capital, "the system under which, in the first place, a substantial and known share of the profit of a business belongs to the workers in it, not by right of any shares they may hold, or any other title, but simply by the right of the labor they have contributed to make the profit; and, in the second place,

every worker is at liberty to invest his profit or any other savings in shares of the society or company, and so become a member entitled to vote on the affairs of the body which employs him."

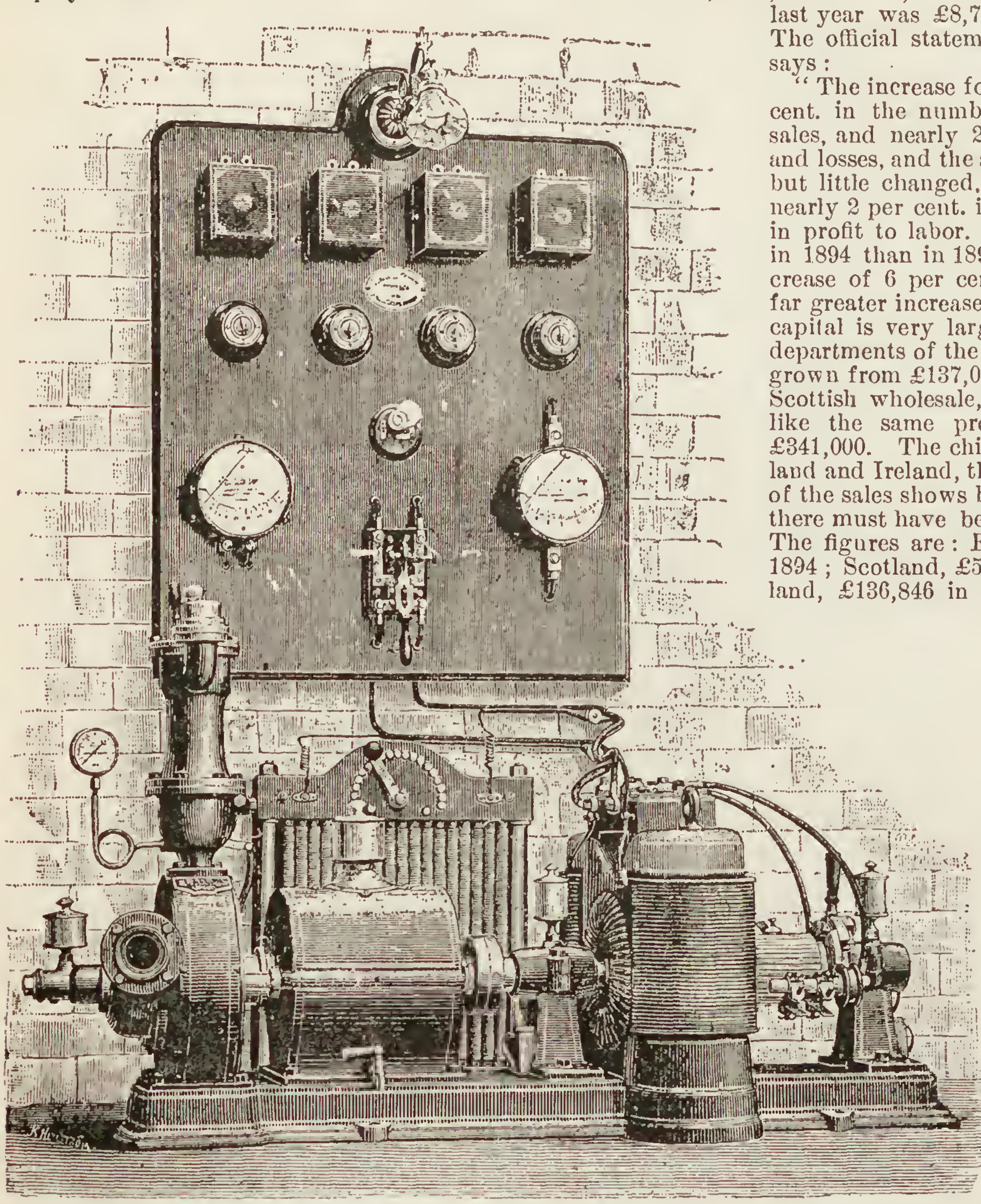


Fig. 34.—VIEW OF A COMPLETE ELECTRICAL INSTALLATION.

This system is carried out by the societies which exhibited the products at the Crystal Palace, and by the other societies in affiliation with the Association, numbering in all 120. Some idea of the growth of the movement may be gathered from

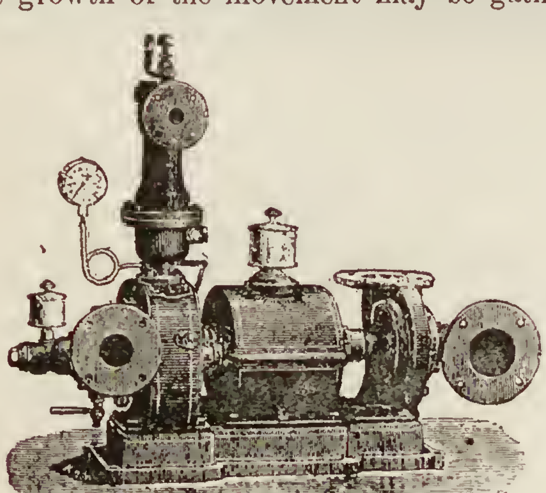


Fig. 35.—TURBINE AND PUMP.

the results of the working of these societies during last year. The number of societies has grown from 15 in 1883 to 109 in 1893 and 120 in 1894. Last year the sales amounted to £1,371,424, against £1,292,550 in 1893 and £160,751 in 1883. The capital (share, reserve, and loan), which was £103,436 in 1883, had grown to £639,884 in 1893 and £799,460 last year. As to profits, these amounted to £68,987 in 1894, to £67,663 in 1893, and £9,031 in 1883; the losses were £3,135 in 1894, £2,984 in 1893, and £114 in 1883, leaving the net profit £65,852, against £64,679 in 1893, and £8,917 in 1883. The "profit to labor" last year was £8,751 against £8,283 in the previous year. The official statement from which these figures are taken says:

"The increase for the year, it will be noticed, is 10 per cent. in the number of societies, 6 per cent. in value of sales, and nearly 25 per cent. in capital; while in profits and losses, and the amount of profit to labor, the figures are but little changed, there being, however, an increase of nearly 2 per cent. in net profits, and of about 5½ per cent. in profit to labor. Seeing how much lower prices were in 1894 than in 1893, there can be no doubt that the increase of 6 per cent. in the value of goods sold covers a far greater increase in their volume. The great increase in capital is very largely accounted for by the productive departments of the Scottish wholesale, where the item has grown from £137,000 to nearly £249,000. The sales of the Scottish wholesale, however, have not grown in anything like the same proportion, but only from £295,000 to £341,000. The chief increases in sales have been in Scotland and Ireland, though even in England, where the value of the sales shows but a very small increase for the year, there must have been a considerable increase in volume. The figures are: England, £633,034 in 1893, £634,482 in 1894; Scotland, £522,670 in 1893, £583,118 in 1894; Ireland, £136,846 in 1893, £153,824 in 1894. In England, too, the profits are slightly less than in 1893, and the losses slightly more; while in Scotland and Ireland the profits are increased, and, as in 1893, no one of the Scottish societies shows a loss upon the year. Of the total losses shown—viz., £3,135—one society is responsible for £2,141. No losses are shown for Ireland, but the figures for that country are evidently incomplete. As to the expression, "profit to labor," only that part of the profit is meant which is allotted to the workers individually as dividend on wages. But it is the workers collectively who get the benefit of provident, educational, and special service funds, to which large shares of the profit usually go. Further, the workers get a large part of the profit assigned to committeemen, and the interest and profit to shares also go largely to them—often in respect of capitalized dividends on their wages. Finally, wages are often substantially higher than they would get elsewhere, and employment is more continuous. It would, therefore, be safe to take about double the £8,751 shown above as the real "profit to labor"—the money profit

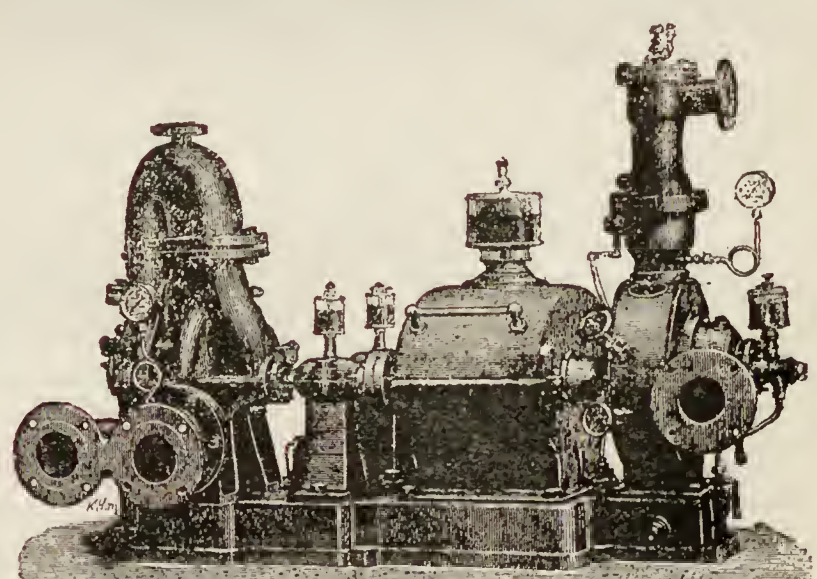


Fig. 36.—TURBINE AND COMPOUND PUMP.

we mean, apart from all other advantages. Four English societies—the Bramley Boot, Atherston Hat, Bolton Common-

wealth, and Walsall Bridle Bit—and one Irish—the Castlemahon Creamery—have failed during the year. They represented a trade of £9,779 only. Another society, whose trade in 1893 was £23,000, has been reconstructed, after compounding with its creditors ; and one very small society, the Walsall Cart Gear, has been amalgamated with the Padlock Society of the same town. Upon the whole we may consider that the societies have stood the strain of one of the worst years known to British trade in this generation remarkably well. The fact that they have shown substantial growth—taken at least at 10 per cent.—even in such a year is good proof of their vitality ; and the indications point to excellent progress in 1895. The above figures only apply to co-partnership in what are usually reckoned as co-operative bodies. There is another large growth of the movement—namely, the adoption of co-partnership in large capitalistic establishments."

In opening the exhibition Mr. Channing, M.P., said : "In the matter of co-operative production they had passed the initial stage and had taken a firm stand upon ground from which they could not be pushed back. This was that the producer should have a reasonable share in the profits of his work, and that he should have as direct and as adequate a share as could be given him in the management and control of the industry with which he was connected. The adoption of such a principle secured the most honest and the most practically useful labor in the world. According to the official reports of the Board of Trade, the weekly wages lost in 1892, owing to strikes and lock-outs, amounted in eight weeks to about £3,880,000, and in 1893 to £6,400,000. If, therefore, the capital of £800,000 was enough to enable 120 co-operative productive societies to work with success, the two sums he had mentioned would enable 12,000 of such societies to work."

During the opening session of the Congress Earl Grey occupied the chair, and in his presidential address took the following somewhat roseate view of co-operation :

"Wherever profit sharing had been at work successfully for some years the most satisfactory results were visible. It acted as a great lubricant, reducing the liability of friction between individuals and departments ; it induced a system of mutual foremanship, and consequently reduced the need for supervision ; it encouraged fertility of resource in overcoming difficulties, devised cheaper methods of production, established a pleasant feeling of brotherhood among all connected with the work, and tended to remove that poisonous antagonism between employer and employed which constituted at the present time the greatest danger with which civilized society was threatened. (Cheers.) For in every corner of the civilized world, wherever labor had only a fixed and limited interest in the product of the industry in which it was engaged, the same ugly phenomena were to be found, in varying degrees, in the rival camps of employers and employed—secrecy, suspicion, angry jealousy, and growling discontent. It did not require a Solomon to tell them that when there was such an antagonism the result would be loss. By the desire of discontented workmen to do as little as possible in return for their wages and the desire of the employers to give as little as possible for the work they obtained two great evils were produced. The national output, on which the prosperity of society depended, was diminished, and the standard of character, on which the greatness of the State still more depended, was deteriorated. He had watched for many years the operation of the wage system in agriculture, and had long ago come to the conclusion that the present system tended to degrade the worker into an unthinking, mechanical automaton. What they wanted was some system which would raise that dull and soulless automaton into a cheerful, hopeful, thinking man. Experience went to show them that the only way to vitalize those human automata of industry back to manhood was to convert the hireling, with limited personal interests, into the partner, with wide and enlarged sympathies, and anxious, by reason of the interest which came from his partnership in the industry in which he was engaged, to make it a success." (Cheers.)

Later on, however, he admitted that the only difficulty in the way of applying the principle "was the want of any profits to divide." This is fundamental and serious, and is characteristic of all business enterprises, public, corporate, and individual.

In commenting on his remarks, the London *Times* says :

"Earl Grey adopted a tone not uncommon on similar occasions. He was enthusiastic, but full of a pained surprise that more people and more organizations did not enlist under the co-operative banner. That, indeed, is just what puzzles the ordinary onlooker. The figures quoted by Lord Grey are the usual figures—so many millions of turnover, so much profit to divide, the millions and the percentage being pretty much what they have been for a long time past. Looking to other nations, this congress being specially and emphatically international, Lord Grey of course quoted France ; but it is a little disappointing, at this time of day, that he has no other instances to quote than those of Godin and Leclaire. These are very old friends, and what the outside world wants to know is whether they have not been imitated. If they have not, it affords a strong presumption that some personal reasons are there to account for their success ; for nothing is more certain than that a successful commercial experiment, if its success is due to causes that are the same for everybody, very soon finds people to copy it. Lord Grey spoke up very zealously in favor of profit-sharing, appearing to identify it with co operation, from which it is really distinct ; but, as he well knows, there are many grave difficulties behind. It may be a simple matter for an employer and his men to agree upon some kind of profit-sharing ; but the pinch comes as soon as the men claim a voice in the management. Again, the case is seen to be not so simple as Lord Grey would wish to represent it when we read his rather naïve remark that capitalists would put their businesses on a profit-sharing basis 'as soon as the conditions of trade were favorable to the application of the profit-sharing principle.' Those conditions are favorable just when they are favorable to raising wages ; and the trade-unions, for whose countenance Lord Grey appeals with some asperity, frankly prefer high wages. The chairman of the congress tells them that by refusing to admit the profit-sharing principle they are retarding the emancipation of labor, and we are inclined to agree with him. But he is surely aware that the trade-unions do not admit that emancipation lies that way. The question is fundamental ; the co-operators and the profit-sharers answer it one way and the trade-unions another. It is, however, very desirable that in certain industries profit-sharing should be more widely tried, and especially, as Lord Grey said, in agriculture. But here again comes in that difficulty—the want, too often felt just now, of any profits to divide. It is quite an open question whether a laborer, if offered a choice between ten shillings a week with a share of profits and twelve shillings with no share, would not choose the latter."

In confirmation of the opinions of the *Times*, M. D. Andremont, of Belgium, said he was obliged to report unfavorably of the experiments made in that country on behalf of co-operative production. The main cause of failure was that the workmen were wanting in the necessary recognition of the difference of capacity which made it necessary that the manager of a co-operative productive institution should exercise adequate authority.

The Rev. Dr. Lorimer, of Boston, U. S. A., held that, when they had discovered the secret of real co-operation between all classes, then they would have entered upon a period of universal peace and happiness and prosperity.

Probably most readers will be disposed to agree both with the London *Times* and the American reverend doctor, provided there is a secret of co-operation which is doubtful. In this, as in so many other cases, it is a condition and not a theory which confronts us. Still productive co-operation does not seem hopeless. Co-operation for distribution is probably as difficult to accomplish in this and many other countries as co-operative production is in Great Britain. Co-operative stores have thus far invariably failed here, not because the theory of them is not correct, but because the condition of the people who should be most interested in them is not up to the co-operative requirements. Impatience of restraint and authority, insubordination, ignorance are insurmountable obstacles in the way of success in this direction. In all the so-called "communities" which have been economically successful, such as that at Oneida, Economy, near Pittsburg, the Mormons, and in all great corporations and trusts, like the Standard Oil Company, the republican or democratic doctrine of equality of capacity and control is totally ignored. Mr. Andremont pointed out the difficulty very clearly when he said that the workmen in Belgium were wanting in the necessary recognition of the difference of capacity which made it necessary that the manager of a co-operative productive institution should exercise adequate authority. What seems needed, not only in co-operative enterprises, but in all government, is some principle or system which will give authority to those who are fittest to control. Universal suffrage don't do that, never did, and never will. Co-operative production directed by the counting of noses will probably never succeed. Some sort of autocracy of intelligence and ethical capacity and not demotic government must have control.

Exhibition in South Africa.—A notice has been forwarded to us of an exhibition which is to be held in Cape Town, under the management of the American Exposition Company, and which will open on November 18, 1895, for a period of six weeks.

MALLEABLE CAST IRON.

In a paper that was read recently before the American Society of Civil Engineers, Mr. H. R. Stanford gives some interesting facts regarding the processes of making and the properties of malleable cast iron. At the outset he makes the remark, to which we will all agree, that if any systematic and scientific study has been made of malleable cast iron, the results have been very carefully kept private. He assigns as a reason for this neglect the fact that, until recently, only very unimportant shapes, as far as strength and uniformity were concerned, were made by the process, and specifications and inspections were not needed. The late extensive use of malleable cast iron in the Master Car-Builders' vertical plane coupler required the metal in a form in which it was subjected to very hard and uncertain usage, and where failure to withstand that usage might result in serious loss of life as well as property. The importance of quality in the castings led to the drop test being inserted in the Master Car Builders' specifications, and malleable cast iron was first subjected to test treatment.

Next to iron, the most important element in malleable cast iron is carbon. A high percentage of carbon is necessary for fluidity ; and fluidity is of prime importance, not only that the percentage of lost moulds may be small, but that the iron may run clean and smooth, and the resulting work have a perfect surface. For strength and malleability the unannealed castings must have no graphitic carbon, but the total percentage must be in the combined state. With a given molten iron at a certain temperature, if the iron be poured into a mould of a certain section the casting will contain all of the carbon in the combined state, and the fracture of the annealed specimen will be of a uniform dark fibrous appearance. If the mould be of a smaller section, the casting made from the same iron will show the total percentage of carbon as combined carbon, but there will be a surface chill, which in the annealed specimen will show as a white skin. If the mould be of a greater section, then the rate of cooling of the iron will be so slow that a part of the carbon will have time to separate from the iron as graphitic carbon, and will show in the fractured unannealed casting as scattered spots of graphite about as large as the head of a small pin, the number of spots increasing with the section of the casting. The above three castings, if annealed, will show the following physical properties. The first will have an ultimate strength of from 42,000 to 46,000 lbs., and will stretch and reduce about 6 per cent., and may be considered a most desirable iron. The second will show in fracture a white crystalline skin, increasing in thickness as the section is lighter, with a black fibrous centre ; the ultimate strength will be about 52,000 lbs., and the stretch and reduction about 3.5 per cent.; if the section is so light that the whole fracture is white, then the iron will be very malleable and tough. The third casting will be little better than gray iron, with a strength of from 25,000 to 35,000 lbs. depending upon the percentage of graphite in the unannealed iron, and with practically no stretch or reduction.

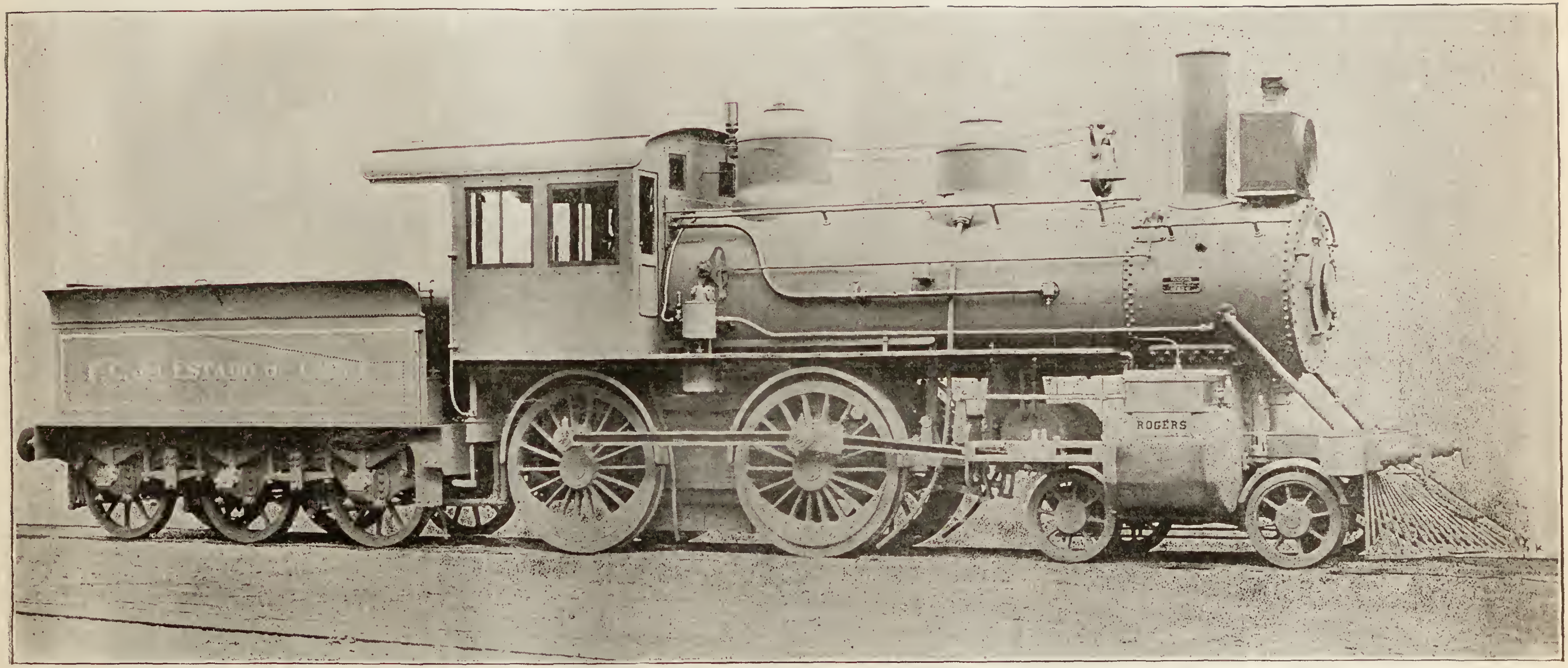
The chemical action in the furnace seems to be primarily the combining of the graphitic carbon of the charge with the iron, a combination made possible in the fused mass by the temperature ; and secondarily a small burning out of carbon and slagging out of silicon and manganese. The secret of mixing is in using material containing combined and graphitic carbon in such proportions that at the temperature best adapted for pouring the graphitic carbon shall all have combined with the iron. To assist in preventing chilling in the mould, a limited amount of silicon is desirable. A chill is objectionable because in one piece there will be two different kinds of iron which have different physical properties and which do not act the same in service. Either kind of iron by itself would be stronger than in combination with the other. Chemical action involves atoms ; therefore if all carbon exists in the combined state in the annealed iron, it must be distributed through the mass in infinitesimally small particles, and when these particles are liberated from the iron in the subsequent process of annealing, they must each be enclosed in an iron cell. Hence the definition might be given for malleable cast iron that it is essentially a mixture of metallic iron and graphitic carbon, the carbon being in finely divided or atomic particles and the iron being the matrix for these particles. Gray iron differs from malleable cast iron in that the carbon, instead of being in atomic particles, is in crystals, and these crystals cut the iron structure and make it discontinuous. In malleable cast iron the continuous cellular iron structure is responsible for the strength of the product, and its malleability and ductility are limited by the non-deformable particles of graphite which occupy the cells. The process of making malleable cast iron is then first to make the hard, brittle carbide of iron which is a stable compound of ordinary temperature. This step is possible because of the affinity of iron for carbon at high temperatures, and the inability of the carbon to separate from the iron in the limited time required for the compound to cool in moulds ; and, secondly, to change the carbon from the combined to the graphitic state by annealing. This step is possible because of the inability of the iron to hold carbon in combination if the compound is slowly cooled from a high to a low temperature.

Shrinkage is a function of casting temperature, and the nearer the iron is to the gray state and yet shows no graphite in fracture, the less will be the shrinkage. The normal shrinkage of hard iron is very nearly ¼ in. to the foot, and there is an expansion of about ⅛ in. to the foot as the effect of the annealing process, so that the net shrinkage is about ⅛ in. to the foot, or about the same as for gray iron. Inasmuch as shrinkage depends upon the condition of the carbon, and the condition of the carbon depends upon the section of the moulds, and because abnormal shrinkage is so undesirable, the necessity arises for different mixtures for different patterns. The shrinkage of cupola iron prohibits its use for a great many shapes, because of the imperfect mixing that necessarily characterizes cupola melting, and because of the factor of safety required in the charge to be sure of avoiding gray iron in the castings.

After carbon, sulphur is the next important element in malleable cast iron. Sulphur tends to hold the carbon in combination with the iron and gives a stronger product because of the semi-steel which it produces. Sulphur is undesirable because of the hindrance it offers to annealing. The shapes ordinarily made by this process need not have great strength, but it is desirable that they be soft and capable of bending, and that the time of manufacture and cost be as low as possible. To show how sulphur affects the time necessary to anneal, couplers which analyzed about 0.040 per cent. in sulphur, and in which were sections about 1½ in. thick, were thoroughly annealed in three and one-half days, while iron bands for buggy wheels, which were no more than $\frac{3}{16}$ in. thick and analyzed about 0.150 per cent. in sulphur, were invariably hard if given less than five days. If sulphur is carried as high as 0.200 per cent., enough carbon is retained in the combined state to give to fractures a uniform crystalline appearance, and the method is employed to make a so-called hard or special steel. This product in ordinary sections does not anneal in less than nine days. Special pains should be taken when buying coke for cupola melting to get a coke low in sulphur, as the iron coming in contact with the fuel picks up sulphur, and delay in the annealing process, with the accompanying wastes, is the result.

It is very unusual to machine any form made of malleable cast iron, as such treatment removes the strongest portion, the skin ; and a tool, no matter how sharp, tends to drag the metal, and so leave small scratches or furrows, which offer starting places for breaking. An undressed cast form is necessarily irregular, and this irregularity, increased by the draft of the pattern, made the measurement of the original area and of the fractured area rather unsatisfactory work, and that the error might be partially eliminated, several bars of each kind were broken and the results averaged. With the idea that a cylinder can be cast more perfectly than a rectangle and that in a cylinder the shrinkage is not so damaging as in a rectangle, the form of the test bar was changed, and bars beginning with one 2 in. between shoulders and $\frac{13}{16}$ in. in diameter were used. In the first set of bars the unannealed sample was taken from the same bar, which was afterward drilled in the flat part for the annealed sample. For the cylindrical specimens, one of the unannealed bars was broken and the sample taken from the portion $\frac{13}{16}$ in. in diameter, and the annealed specimen was taken from near the fracture of one of the tested bars. In every case more weight should be given to elongation than to reduction of area, because of difficulties in determining the exact areas for computing the latter. With the exception of one case, the bars composing the sets were cast from the same ladleful of iron, drawn about the middle ladleful of the heat. All test bars received the same treatment in the annealing oven as far as position in the annealing pots and location in the oven were concerned.

The results obtained are not sufficiently numerous and uniform to warrant any general conclusions regarding the effect of manganese and phosphorus, further than to say that phosphorus seems to be a very passive element and anything but the bugbear which it is in steel. A limited period of anneal, judging from the results, might be considered as giving better results than an indefinitely longer one, both as regards strength and malleability. The fact that there was no sure way of telling whether bars were thoroughly annealed and yet not weakened by over anneal makes the physical results given a



TWO-CYLINDER COMPOUND LOCOMOTIVE.

BUILT BY THE ROGERS LOCOMOTIVE WORKS, PATERSON, N. J., FROM THE DESIGNS OF MR. REUBEN WELLS, SUPERINTENDENT.

little uncertain as representing an iron corresponding to the analyses accompanying the results, and only by averages of many tests can the truth be known.

In the tables that are appended to this paper the author has given some valuable and interesting information regarding the strength and other physical properties of malleable cast iron. In a large number of samples made from charcoal pig iron it was found that the average tensile strength per square inch was 42,910 lbs., with a percentage of reduction of 3.81 and of elongation of 3.97. With samples taken from castings made from coke pig the tensile strength was 47,930 lbs. per square inch, and a percentage of reduction of 4.41 and of elongation of 5.81. If the author would supplement this work by a report on the observed limit of elasticity of malle able iron, he would add to the obligations that he has placed upon the engineering community, since that is really the point by which the practical utility of the metal is marked.

COMPOUND LOCOMOTIVE FOR THE STATE RAILWAYS OF CHILI.

The accompanying engraving is from a photograph of a compound locomotive recently completed at the Rogers Locomotive Works, from designs by Mr. Reuben Wells, the Superintendent of those works. The gauge of the Chilian roads is 5 ft. 6 in., and the fuel which will be used is bituminous coal. The weights and general dimensions are as follows :

Total weight	117,000 lbs.
On driving-wheels	72,000 lbs.
" truck-wheels	45,000 lbs.
Wheel base, total	22 ft. 11 in.
Wheel base of driving-wheels	8 ft. 3 in.
Diameter of "	5 ft. 6 in.
" " truck-wheels	2 ft. 9 in.
Size of journals, driving-axles	8 in. × 10 in.
" " " truck-axles	5½ in. × 12 in.
Diameter of high-pressure cylinder	19 in.
" " low " "	28½ in.
Stroke of piston	24 in.
Diameter of piston-rods	3½ in.
Steam ports, H.P. cylinder	22 in. × 1⅝ in.
" " L.P. "	29 in × 1⅝ in.
Exhaust " H.P. "	22 in. × 3¼ in.
" " L.P. "	29 in. × 3¼ in.
Width of bridge	1⅜ in.
Slide valves	Richardson's balanced.
Steam pressure	190 lbs.
Boiler material	Steel.
" " thickness	$\frac{9}{16}$ in. and ⅝ in.
Outside diameter of barrel of boiler at first course	58 in.
Horizontal seams	Butt sextuple-riveted.
Circumferential seams	Double-riveted lap.
Crown sheet stayed with crown bars.	
Diameter of dome	30 in.
Number of tubes	208
Diameter of tubes outside	2 in.
Length of tubes over tube plates	11 ft.
Material of tubes	Brass.
Length of fire-box	5 ft.
Width " "	3 ft. 6 in.
Depth " " front	87½ in.
" " " back	86½ in.
Material of fire-box	Copper.
Thickness of fire-box plates	½ in.
Brick arch in fire-box supported on studs.	
Cast iron grate with stationary bars.	
Boiler is fed by Monitor injectors.	
Capacity of tender, water	3,000 galls.
" " " coal	6 tons.
Tender frame made of ⅞ in. steel slabs.	
Diameter of tender wheels	48½ in.
Material " " "	Wrought iron with steel tires.
" " " axles	Hammered iron.
Journals " " "	5 in. × 8 in.

The engine is equipped with Westinghouse 9½-in. brake-pump, the brakes being applied to the tender-wheels. The cab is made of steel, as shown by the photograph. The roof and inside of cab is lined with wood.

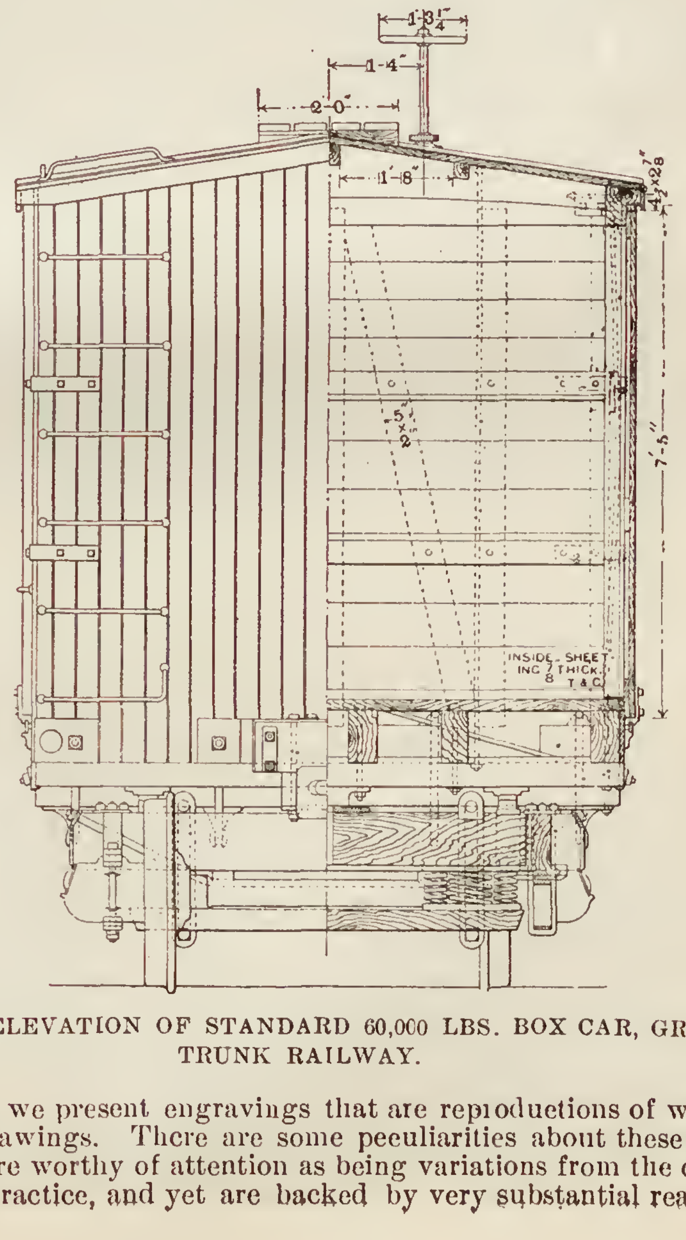
The tender, it will be seen, is of the European type, with six wheels and slab-frames. This design was supplied by the authorities of the road for which the engines are built. It may be said that this design is being regarded with more favor by American engineers of late years than it was when the generation of master mechanics who preceded the present one were in control of our railroad engineering.

It would be impossible to explain the construction of the compound features of this engine fully without elaborate engravings, which we expect to give in a future number. It may be said, though, in a general way, that steam is conducted to the high-pressure cylinder by a pipe in the back part of the smoke-box. The general form of this pipe is that of an inverted letter Ↄ. The exhaust passage of the high-pressure cylinder is connected with the steam-chest of the low-pressure cylinder by a pipe of large diameter of the form of an inverted letter ∩, which also acts as a receiver. This is connected with the high-pressure steam-pipe by another 2-in. pipe, which has a reducing-valve between the receiver and the supply of high-pressure steam. This reducing-valve is arranged so that it can only open when the reverse lever is thrown forward or backward to its extreme limit, and is controlled by the mechanism shown on the side of the boiler in the engraving. Before starting, when the reverse lever is in its forward position, if the throttle-valve is opened, the inflowing steam into the high-pressure steam-pipe opens the reducing-valve, which permits live steam from the boiler to flow into the receiver-pipe, and at the same time closes an intercepting-valve in the receiver-pipe, between the high and low-pressure cylinders, which prevents the live steam which passes through the reducing-valve from entering to the exhaust side of the high-pressure piston. This reducing-valve is so proportioned that it closes when the pressure in the receiver-pipe reaches about 56 per cent of the boiler pressure, and opens when it falls below that. Consequently as soon as the throttle-valve is opened, and before the engine starts, the receiver-pipe is filled with live steam of a reduced boiler pressure, and as soon as the high-pressure cylinder exhausts into the receiver-pipe and increases the pressure, so that it is over 56 per cent. of the boiler pressure, it opens the intercepting-valve, so that steam can flow directly from the exhaust side of the high-pressure cylinder to the steam-chest of the low-pressure cylinder, and simultaneously closes the reducing-valve, so that no more live steam from the boiler can pass directly to the low-pressure cylinder. After the engine has been started and the reverse lever has been pulled back, the reducing-valve is closed and held in that position by the action of the mechanism shown in the engraving.

A number of compound engines of this type have been built by the Rogers Company, and the best evidence of their success is the receipt of duplicate orders.

STANDARD BOX CAR OF 60,000 LBS. CAPACITY —GRAND TRUNK RAILWAY.

The Grand Trunk Railway, a description of whose works at Montreal appears in another column of this issue, has adopted standards for the greater portion of the output of their shops. Among others they have a standard box car, of

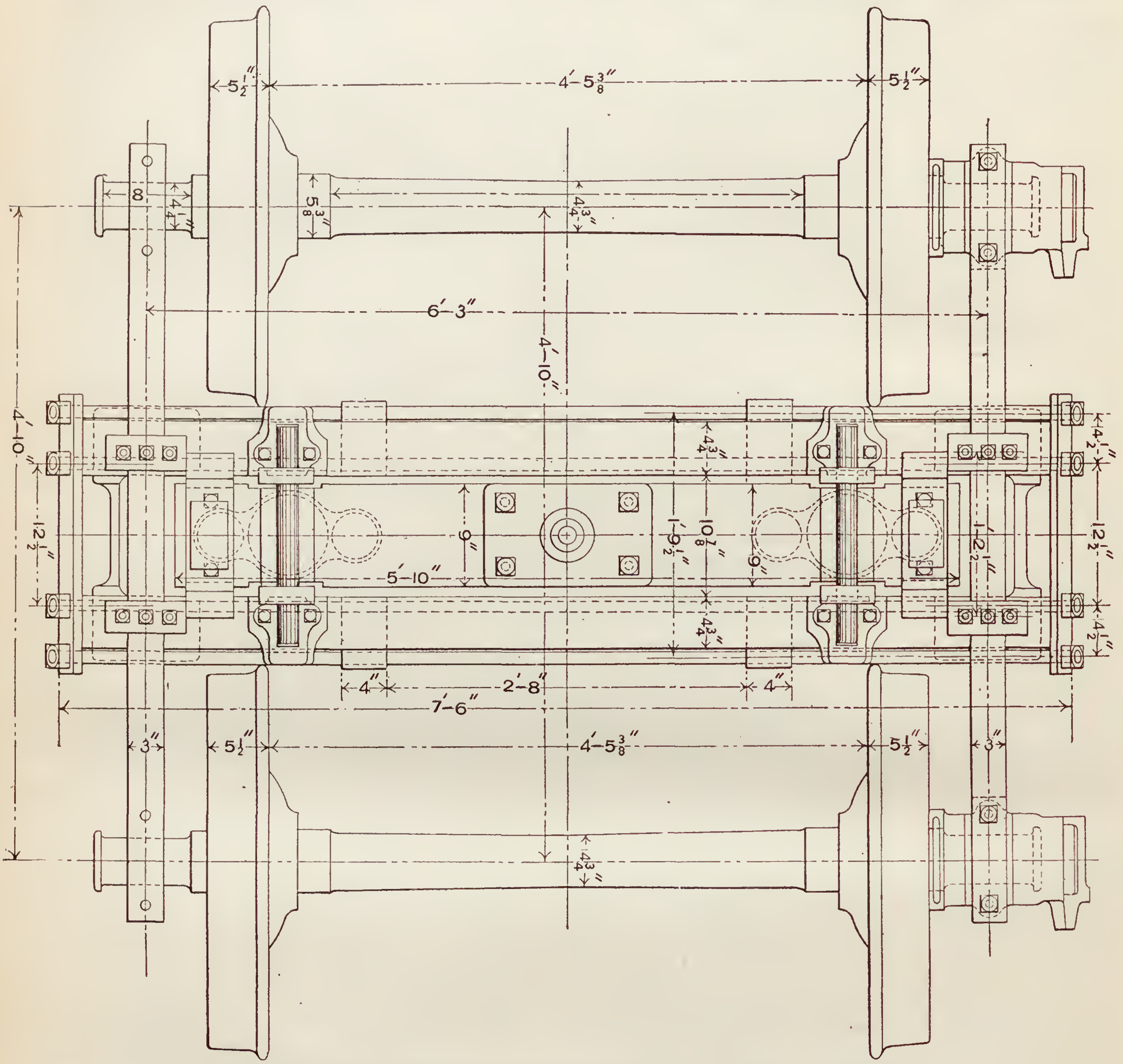


END ELEVATION OF STANDARD 60,000 LBS. BOX CAR, GRAND TRUNK RAILWAY.

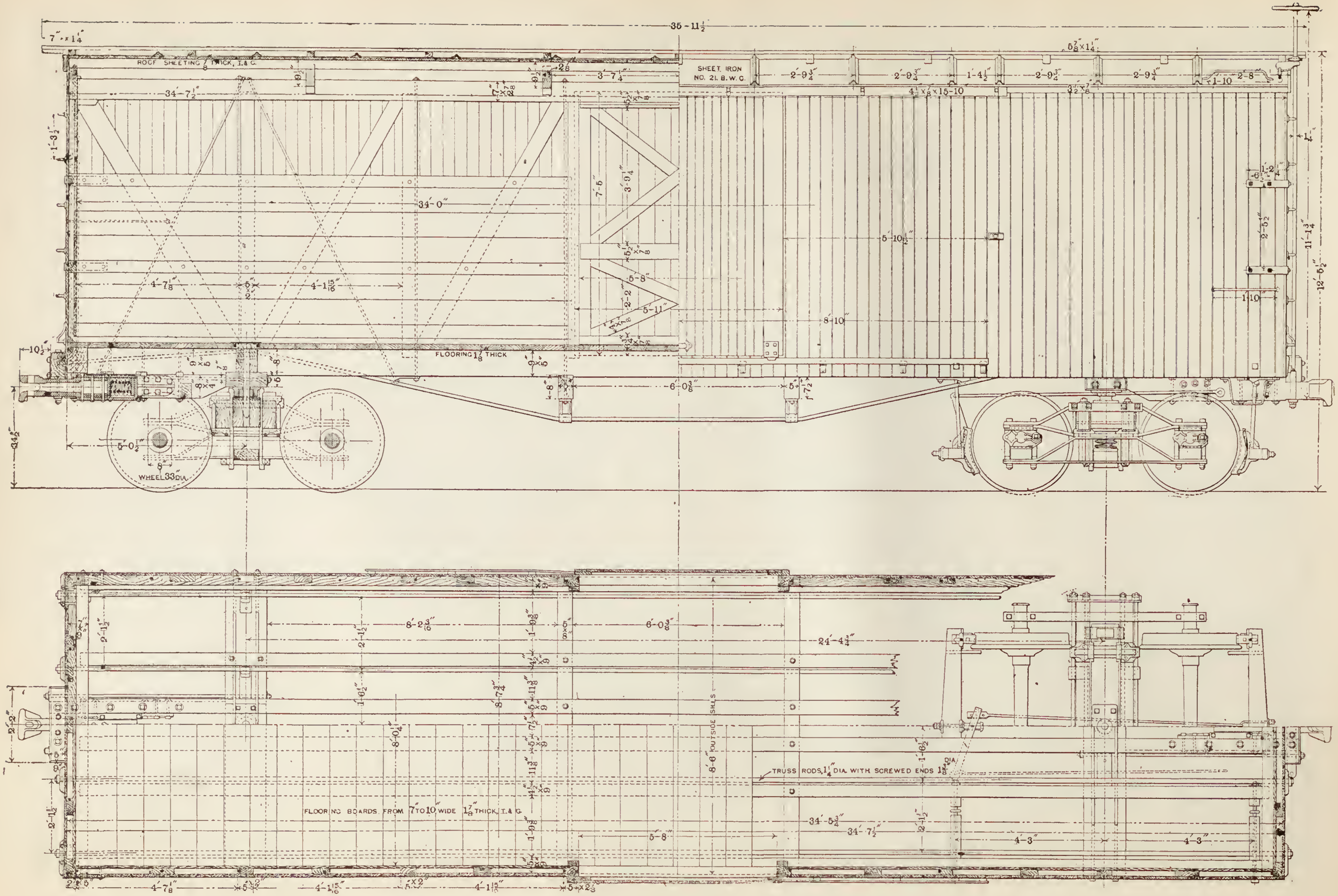
which we present engravings that are reproductions of working drawings. There are some peculiarities about these cars that are worthy of attention as being variations from the common practice, and yet are backed by very substantial reasons

for their existence. In the general outline of the framing there is little variation except in minor details. The counter-brace, for example, is heavier than that used in some places, and the truck centre is brought out nearer to the end of the car. The body bolster is of wood strongly trussed, and the main truss-rods for the body have no turnbuckle in the centre, where we usually find it. The reason given for this is that if the centre of the body sags at all, it must be raised by shortening the truss-rods, and that it makes no difference where those rods are shortened; that is, they may be taken up at the ends or in the middle, indifferently. Also that the raising of the body is not done by simply screwing up the rods, but they are first relieved of all strain by jacking. By the use of the continuous rod, also, the expense of the turnbuckle is saved, and the danger of its slackening off and thus becoming loose obviated. The only objection that can be raised to this construction is that if a rod breaks, it is more difficult to put in a new one where there is no turnbuckle than where one is used; but, on the other hand, the breaking of truss-rods is such a rarity that the saving effected in the other direction is a practical insurance on this one possible source of loss.

As all parts of the car have been reduced to standard sizes, the work of construction is greatly simplified and cheapened. Whether new cars are being built or not, the various parts can be made in quantities, as they will surely be needed for repairs, and in this way the piecework system can be introduced with advantage. Wherever it has been found to be advisable to do so, special machines have been designed to do duplicate work in quantities, and in our next issue we will illustrate a checking machine that has been built in the shops to do the checking or gaining on the belt rails. An examination of the drawing will show that these belt rails have a width of $2\frac{3}{4}$ in., and that the body braces have a width of 2 in. It is therefore necessary that the belt rails should be checked or gained to a depth of 2 in. to allow for the passage of these braces and posts. There are five of these checks in the length of each rail, three of which stand at an angle. To do this on a machine where only one can be done at a time requires considerable time, to say nothing of that required either for the laying out of the work or the setting of the machine and the repeated handling of the parts. With the machine that is used for the purpose no laying out is required, and, after the machine has once been set, everything that comes from it is in exact duplicate and interchangeable. This is evidenced by the ease and rapidity with which the new work can be put together, and the closeness of the joints in the finished framing. The same system is employed in other parts of the cars, such as the body bolsters, the cross-tie timbers, etc.



PLAN OF TRUCK FOR STANDARD 60,000 LBS. BOX CAR, GRAND TRUNK RAILWAY.

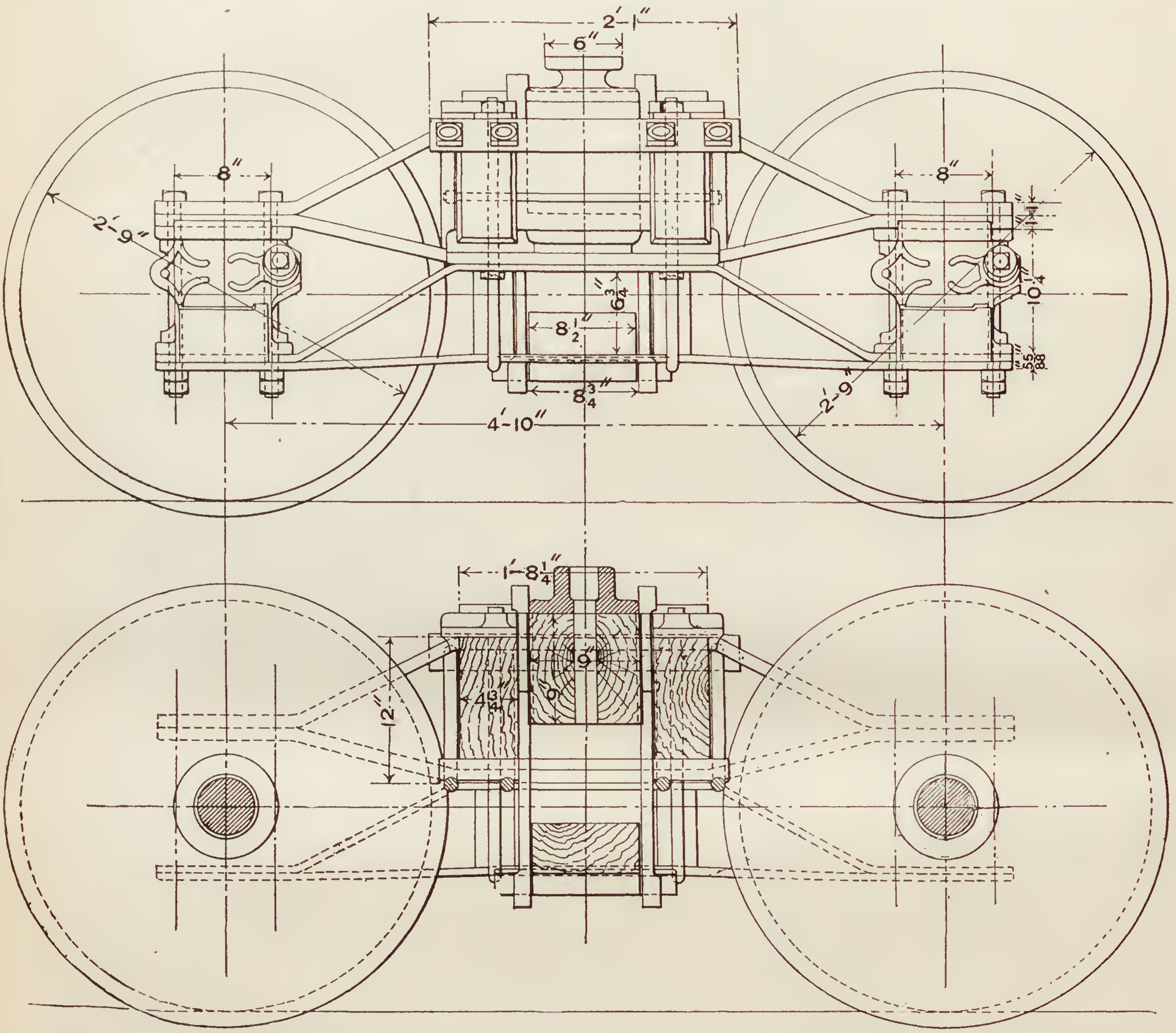


STANDARD 60,000 LBS. CAPACITY BOX CAR, GRAND TRUNK RAILWAY.

The material that is used on these cars is Georgia pine for the longitudinal sills and Michigan oak for the end sills and framing ; the remainder of the car is for the most part made of Canadian white pine, while all of the iron used is from the rolling mill of the company. The castings are made in the foundry at Montreal, and the wheels cast at Hamilton. It is in every sense of the word a home-made car. The only things that come from abroad is the wood that is grown in Michigan and Georgia.

It will be noticed that the coupler shown in the drawing is of the link-and-pin type. This is still in use upon the road, but they have under consideration the adoption of one of the Master Car-Builder type, but have as yet come to no decision in the matter as to which one will be chosen. It is probable, however, that when one is adopted arrangements will be made for the erection of suitable foundries and facilities for manufacturing the same.

With the ordinary bar the column bolts have a diameter of $1\frac{1}{4}$ in., which calls for a hole at least $1\frac{5}{16}$ in. in diameter, and where the car-builder is not sure of the accuracy of his work this hole is increased to $1\frac{3}{8}$ in. With a $1\frac{5}{16}$-in. hole through a 4-in. bar there is left $2\frac{11}{16}$ in. of metal. On this truck the column bolts are only $\frac{3}{4}$ in. in diameter, and the holes in the arch bars are $\frac{13}{16}$ in. This leaves $2\frac{5}{16}$ in. of metal, or just $\frac{1}{2}$ in. less than the usual practice. These small bolts are really not called upon to sustain any of the carrying strains of the truck, since this is done by a $\frac{7}{8}$-in. U bolt that passes beneath the lower arch bar, and is held up by a nut above a plate that lays over the top bar and takes the three bolts that come in a line, as shown in the plan of the truck. These U bolts hold the bars so firmly together that they seem to supplement the strength of the bars, so that no difficulty is experienced by the loss of the $\frac{1}{2}$ in. of metal due to the narrow width of the bars. So, as the proof of the pudding is in the



SIDE ELEVATION AND LONGITUDINAL SECTION OF TRUCK FOR STANDARD 60,000 LBS. BOX CAR, GRAND TRUNK RAILWAY.

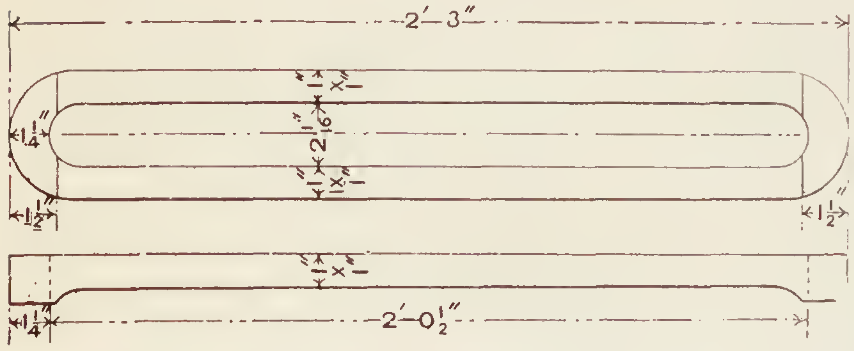
eating thereof, the truck must be considered to be of ample strength, inasmuch as it shows no sign of weakness, and does its work in the service into which it is put.

In regard to the dimensions of the car and of the parts forming it, they are so fully given on the engraving, that we refer our readers to that source for information upon this subject.

The truck that is used under the car varies, perhaps, from the common practice more than the car itself. The first thing to strike the observer is the use of outside-hung brakes, and the small size of the iron used in the arch bars. It has been customary to use iron that measures 4 in. × 1 in. or $1\frac{1}{4}$ in. for the top and intermediate bars, while here we find the width reduced to 3 in. for trucks that are to carry cars of 60,000 lbs. capacity. An examination of the construction, however, will show that the actual amount of metal left after the holes are drilled is about the same as where the wider bars are used.

There may be other places where the same thing is done, but if there are, we are not aware of it ; for in the making of these arch bars they come to the car department at the same cost as that of ordinary rolled iron. As the bar comes from the last pass in the rolling mill it is cut to lengths and shaped for use in the truck while it is still hot, so that there is no extra expense attending the making of the truck frames with the exception of drilling the bolt-holes. It is merely one of the instances that go to show how thoroughly the work in the Montreal shops is systematized, and emphasizes the advan-

tages of having a standard and living in accordance therewith. It will be noticed that the oil-boxes are fitted with the Fletcher journal-box lid. This was adopted by the Grand Trunk Railway at the time the Fletcher lid was the standard of the Master Car Builders' Association, and when the standard

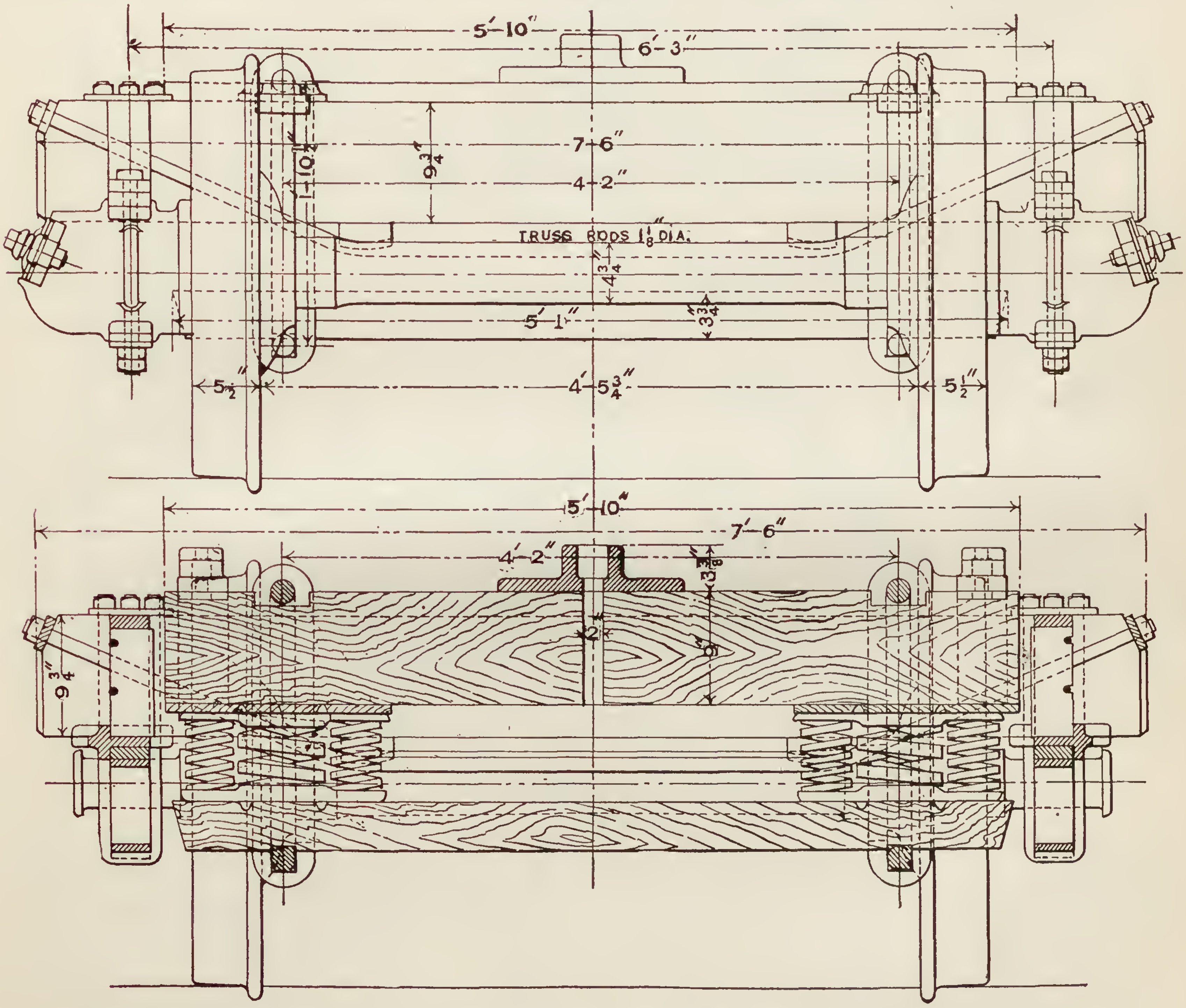


HANGER FOR 60,000 LBS. TRUCK, GRAND TRUNK RAILWAY.

was changed to the present form the road continued its old practice.

The transoms and bolsters of this truck are made of oak that is obtained in Michigan, and it will be noticed that the former are stiffened by deep trusses, two 1⅛-in. rods being used for each piece. This trussing is so deep and strong that it practically carries the whole load that is put upon the truck. The bolster has no trussing at all, and consists of a stick of oak 9 in. square. As the springs come below and inside of the side bearings, and the distance out from the centre is thus made very small, trussing has been found to be unnecessary. We give a small engraving showing the construction of the truck hangers, from which it will be seen that they are strengthened and enlarged at the bearing points. This gives a better wearing surface than where the metal is continued at a uniform thickness over these places.

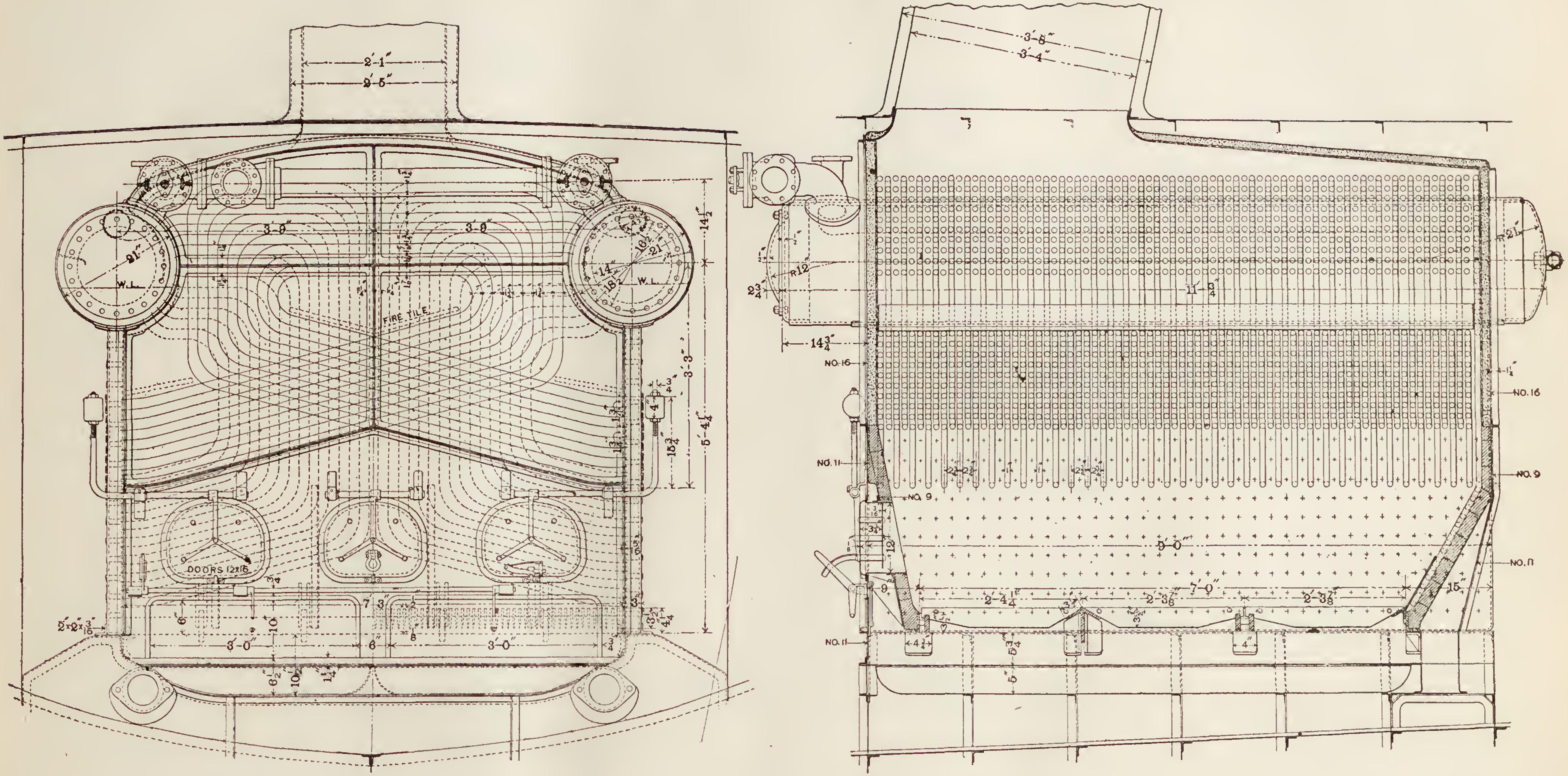
Like the car body, the truck is of home-made material with the exception of the wood, and of course that is all worked on the same plan as that adopted for the other parts of the car, and, like it, its suitability for the service demanded is shown by the service rendered, which is perfectly satisfactory. One of the devices in use upon the car is the nut lock. It consists of a flat piece of sheet iron long enough to reach over two adjacent bolts, and punched to take the same. It is slipped on, and after the nuts are screwed home and squared with each other, the sides of this sheet-iron washer are turned up by means of a cold chisel, thus effectually locking both nuts and positively doing away with all possibility of turning.



END ELEVATION AND CROSS-SECTION OF TRUCK FOR STANDARD 60,000 LBS. BOX CAR, GRAND TRUNK RAILWAY.

MACHINERY FOR THE NEW UNITED STATES TORPEDO-BOATS.

The new torpedo-boats that are to be constructed for the Navy of this country, and which are at present known as torpedo boats Nos. 3, 4, and 5, are designed to have a speed of 24.5 knots per hour, at a displacement of 135 tons. They are to be driven by triple-expansion twin-screw engines built on the lines shown by the accompanying engravings. The two engines will be alike, and each will be placed in a separate water-tight compartment. They will be of the vertical inverted-cylinder, direct-acting, triple-expansion type. The high-pressure cylinder will have a diameter of 12 in., the intermediate a diameter of 19½ in., and there will be two low-

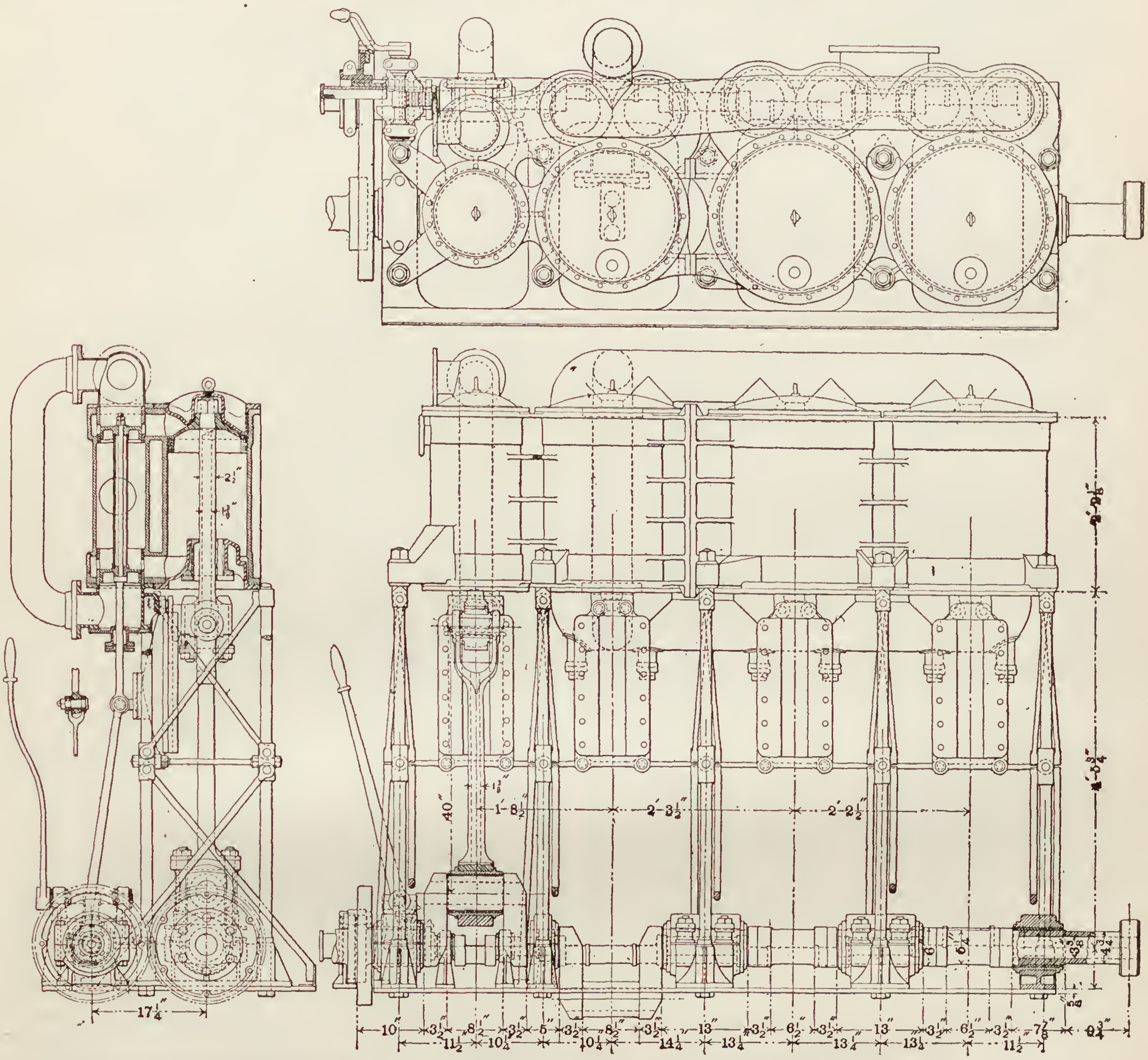


WATER-TUBE BOILERS FOR THE UNITED STATES TORPEDO-BOATS NOS. 3, 4, AND 5.

pressure cylinders, each having a diameter of 22 in., the stroke of all of the pistons being 16 in. It is expected that the I.H.P. of the propelling engines will be about 2,000 when they are running at the rate of 412 revolutions per minute. As the two engines are alike, their positions will be reversed when they are placed in the boat. The starboard engine will have the high-pressure cylinder aft, while it will be forward in the port engine. There is also something of an innovation in the working of the main valves, which will be driven by means of cranks on a shaft parallel to the main engine shaft and geared to that shaft. Piston-valves are to be used for all of the main valves, there being one for each high-pressure, two for each intermediate-pressure, and two for each low-pressure cylinder.

the latter is located aft of the starboard engine, the water-tight compartment for each extending across the vessel. Each of these condensers will have a cooling surface of about 800 sq. ft. measured on the outside of the tubes, and the water will pass through the latter. For each propelling engine there will be a single-acting air-pump driven from the main engine-shaft. The circulating pumps will be of the centrifugal type, and there will be one for each condenser. The propellers will be made rights and lefts, and will probably be ordered of manganese bronze.

Steam will be supplied by two water-tube boilers, a longitudinal and cross-section of which is given by our full-page engraving. They will be constructed to carry a working pressure of 250 lbs. per square inch, and each boiler will be placed in a separate water-tight compartment; one being located forward of the engines and the other aft, as shown in the engravings. Locating the boilers this distance apart necessitates the use of two stacks, one for each. The total grate area of these boilers will be at least 95 sq. ft., and the total heating surface at least 5,120 sq. ft.



PROPELLING ENGINES FOR THE UNITED STATES TORPEDO-BOATS NOS. 3, 4, AND 5.

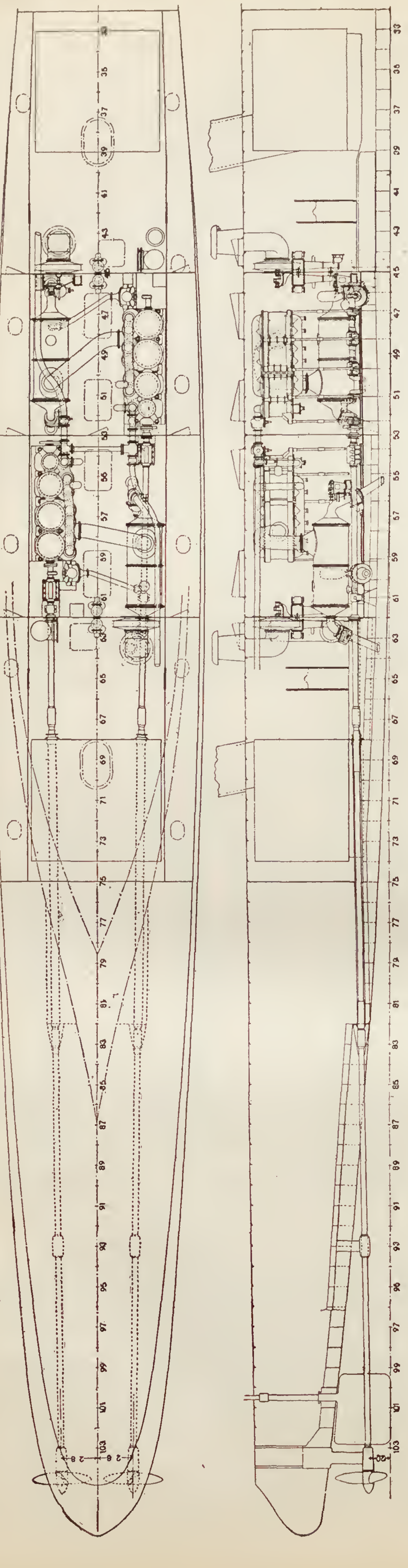
Each main piston will be fitted with one piston rod that will be attached to a cross-head working in a slipper guide. The framing of the engines will consist of vertical forged steel columns well stayed by diagonal braces. The engine bed-plates will be of plate steel, supported on the wrought-steel keelson-plates that are built in the vessel. The crank-shafts will be made in one section, and will be hollow. The shafts, piston-rods, connecting-rods, and working parts generally will be forged of mild, open-hearth steel. The piston-rods, connecting-rods, and valve-rods will also be oil-tempered.

There will be a separate condenser supplied for each engine, and they will be located as indicated in the plan and longitudinal section of the arrangement of the machinery. It will be seen from this that the condenser for the starboard engine is placed forward of the port engine, while the condenser for

In addition to the main feed-pumps there will be an auxiliary feed-pump in each fire-room, and they will be duplicates of the main pumps. The main pumps will be placed in the engine-room, and will have a capacity equal to the supplying of all of the feed when the boilers are steaming at full power under a forced draft.

Among the auxiliary machinery that will be supplied will be two evaporators and one distiller.

As in vessels of every class weight is of the prime impor-



PLAN AND LONGITUDINAL SECTION OF VESSEL SHOWING THE ARRANGEMENTS OF THE MACHINERY IN THE UNITED STATES TORPEDO-BOATS NOS. 3, 4, AND 5.

tance, it is specified that the total weight of all of the machinery for these boats, including boilers, auxiliaries and heaters, and water in the boilers, condensers and pipes, and such stores and spare parts as may be carried on board must not exceed 60 tons.

In regard to the details of construction, the specifications require that all of the crank, line, thrust, and propeller-shafts shall be of forged steel, and that each length shall be forged in one solid piece. The crank-shaft for each propelling engine will, therefore, be in one section. Each crank will, of course, have a throw of 8 in., and the shaft is to have a coupling disk $1\frac{5}{8}$ in. thick forged on to the after end. The crank-pins are to be $5\frac{1}{4}$ in. in diameter and $8\frac{1}{2}$ in. long for the high and intermediate cylinders, and $6\frac{1}{2}$ in. long for the two low-pressure cylinders. All of the journals and crank-pins are to be turned and ground to accuracy. Holes $3\frac{5}{8}$ in. in diameter will be bored through each shaft and crank-pin. The cranks of the high and intermediate cylinders will be opposite to each other, and the cranks of the low-pressure cylinders will be similarly placed, but making an angle of 90° with those of the high and intermediate cylinders. The sequence in the rotation will then be, high-pressure, second low-pressure, intermediate-pressure, and first low-pressure.

As the boilers are to be built for carrying a working pressure of 250 lbs. per square inch, the test pressure to which they will be subjected before being placed in the vessel will be much higher—namely, 360 lbs. This pressure will be obtained by the application of heat to fresh water that has been placed in the boilers, the water filling the boilers quite full. The same pressure will be applied to the steam-pipes, valve, and all of the fittings. Then, after the boilers have been placed in the vessel, and the connections have been made, they will be subjected to a second test under a pressure of 300 lbs. per square inch, in order that all of the leaks may be made tight before the jacketing is put on. Tests of the same severity will be made on the engine, where the high pressure cylinders and valve-chests will be subjected to a hydrostatic pressure of 360 lbs. per square inch, those of the intermediate to 180 lbs., and those of the low-pressure to 90 lbs. The pumps, valve-boxes, air vessels, and the pipes of all of the feed-pumps will be tested to 500 lbs. per square inch. The circulating pumps will be tested by discharging water under conditions as nearly as possible like those they will be working under when throwing water from the bilges, and will be required to discharge 750 galls. of water per minute under a head equal to that under which they will be working when in the vessel and discharging into the sea above the water-line.

In a future issue we expect to publish full particulars regarding the construction of these boats with reproductions of photographs.

NATIONAL MANUFACTURERS' ASSOCIATION.

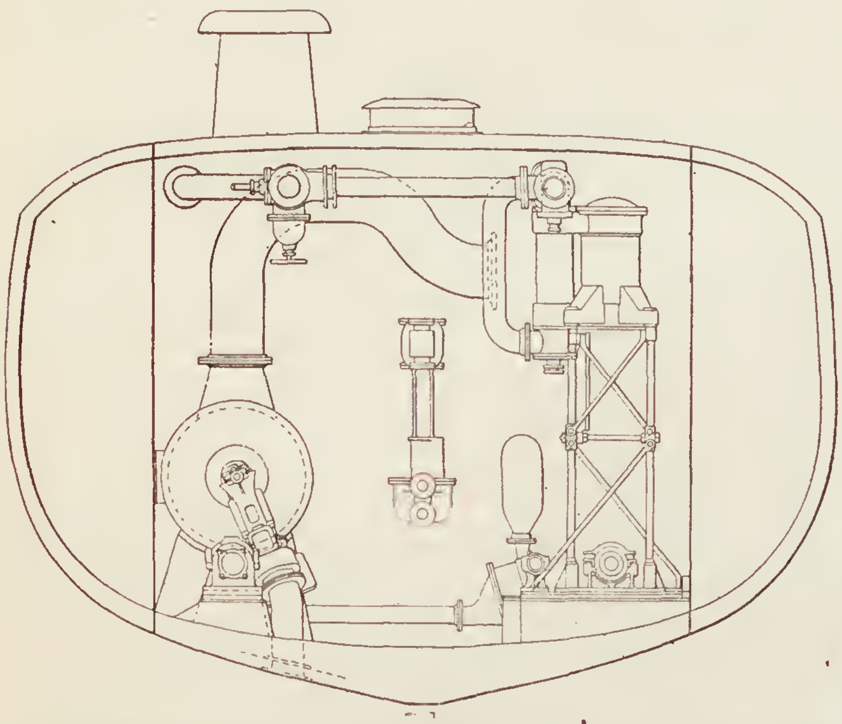
By Thomas P. Egan, President of J. A. Fay & Co., and the Egan Co.

The country has hardly yet realized that a new agency of great power is now at work; heretofore they have worked singly, but now the manufacturers of the United States are cementing themselves into an organization that will be far-reaching in its effects.

The industrial interests of this country have reached such magnitude as to make a national organization almost a matter of absolute necessity, as our manufacturers are now annually turning out twice as much in aggregate value as the total farm products of the country. An organization of this kind, bringing manufacturers of all sections together, working for the common good of all, without sectional or party interests to serve but simply the good of the country and of its industrial welfare at heart, can be made of incalculable value.

The men at the head of this undertaking are painstaking business men, and who have no "axe to grind" in a political way, and no preference for anything but what will be a benefit to the United States. When the recent tariff bill was under discussion, the manufacturers of the United States, it is true, made their protests; but it is also true their protests were made singly against the sweeping reductions in the tariff, and consequently carried little weight. In the future the manufacturers of the United States propose to speak as a unit through organization, and if this coalition had been effected before the Wilson bill was formed, we doubt if it would have carried the want, depression and woe with it that it has, for it would have been so modified that it could have been made an advantage, instead of a great disadvantage, to the United States.

The manufacturers of the United States, when in convention in October 15–17, at Chicago, propose to take this question up and discuss it effectually. From all the present indications, every State in the Union will be well represented by its very best manufacturers. The delegation from Ohio will be the equal of any from any State in the country. The vice-president for each State has the selection of the delegates, and the vice-president from Ohio proposes to use the best material that is presented, without regard to politics. The delegation from the southern part of Ohio will include such men as Mr. M. E. Ingalls, Mr. Charles Davis, Mr. E. C. Goshorn, as well as the Vice-President himself, Mr. Thomas P. Egan. The

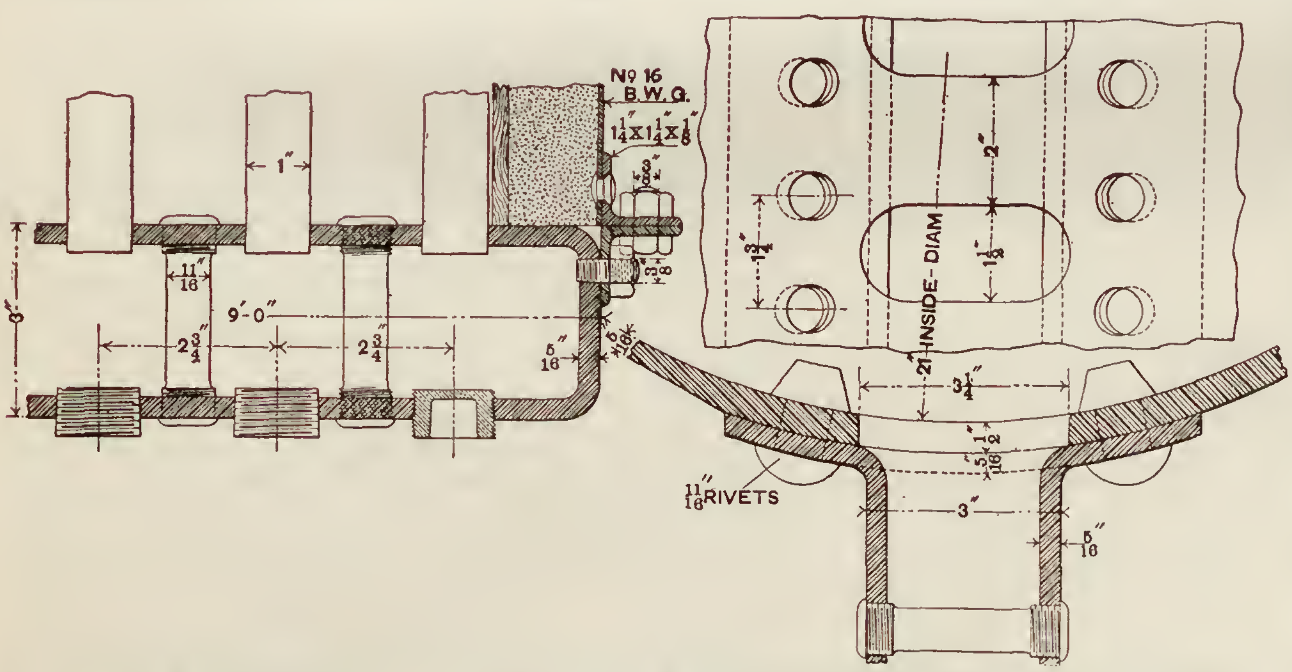


CROSS-SECTION AT ENGINE-ROOM OF THE UNITED STATES TORPEDO-BOATS NOS. 3, 4, AND 5.

delegation from the northern part of the State will be picked with equal care, and accordingly the best men in the State will be selected.

The results of the convention of the National Manufacturers' Association, to be held in Chicago this month, will have a great weight in shaping the industries of the country affected by tariff legislation and the fortunes of the manufacturers of the United States, without the least regard to politics. The manufacturers propose never to allow themselves to be disregarded and their interests to be seriously affected by any action of Congress prejudicial to the good of the country without being heard from, as was the case when the last Congress rescinded the valuable reciprocity treaties which were then in force and framed a tariff under which it is almost impossible for the manufacturers to exist.

Any action by any of the political parties of this country which hurts the manufacturer, hurts the workman in an equal if not greater degree. Let us hope that the convention of the National Manufacturers' Association to be held in Chicago in the fall, from which so much is expected, will handle matters fairly, and consequently for the best interests of the people in general. Much is expected of this convention, and it will be a great disappointment to many if it does not rise to the occasion. It will be composed of about 450 representative delegates, representing all the business sections of the country. It will be a far different one from the one held in Cincinnati, which was, of course, merely preliminary, for every manufacturer who could come registered his name; but now each State will have its proportionate number of representatives, which is five from each State, and then each State is entitled to one more delegate for every $50,000,000 of produce, which is to be governed by the last census. By this means all will have an equal representation in their proportion as to production. We trust that every vice-president for each State will exercise the greatest care in the selection of delegates, so as to make up one of the most representative bodies of manufacturers ever held.



DETAIL SHOWING METHOD OF FASTENING TUBES IN THE BOILERS FOR THE UNITED STATES TORPEDO-BOATS NOS. 3, 4, AND 5.

AMONG THE SHOPS.

THE GRAND TRUNK SHOPS AT MONTREAL.

The Grand Trunk Railway is in a situation peculiar to itself and one not at all similar to any other on this side of the Atlantic. Located as it is in Canada, it is cut off from the manufactories of this country by the bar of the Canadian customs duties. Under these circumstances, then, the management have found it to be advisable to manufacture a far larger proportion of its own supplies than would be the case were it possible to buy direct from the American manufacturer without the intervention of the duties, which so raise the cost to the railroad company that it has been found to be more economical to put special machinery into their shops and enter upon an industry on a scale that would not have been thought of had circumstances and purchasing facilities been better.

The main shops of the company, where the major portion of their work is done, and from which supplies are issued, is located at Point St. Charles, in the city of Montreal, and occupy a tract of 40 acres; the buildings themselves cover 11 acres of this ground. The buildings are all of one story in height, and though they have been erected from time to time as the necessities of the work to be done has demanded, and without any reference to a prearranged plan, they are convenient and readily accessible from one department to another, and the handling of material is so provided for that there is no delay or extra expense entailed.

In the material used, a complete cycle seems to be traversed; starting from new stock through the various stages of wear, tear and repairs, we find ourselves at last by the scrap heap, whence the old iron emerges, like the phœnix, to do duty again as new material in the shape of bar-iron axles and forgings. Perhaps, then, it may be as well to start in at the scrap heap, where the road has an extra large amount of iron. Years ago, when the steel rail began to supplant the iron for main line work, the latter was relaid in sidings and spurs, where it has served its purpose until the once new steel began to show signs of wear and required replacing. As iron is much more readily handled than steel, the old iron sidings are being torn up, steel put in the place, and the iron sent to the company's mill for reworking. The scrap-handling department of the mill is, perhaps, its most interesting, if not the most important feature. The old boiler plate is heaped up at one end of the scrap-working shed, the old rails come in at one side, and the smaller scrap is piled up in one corner. The latter is piled upon shingles to the amount of about 200 lbs. and is then heated and hammered in the ordinary way. The rails come in on a long slide like a runway for logs, and are cut off to lengths of about 3 ft., and then fagotted for welding. In this scrap shed there are four sets of shears driven by three steam engines that are integral parts of the machines. Three of the shears

were built by a Canadian manufacturing firm, and the fourth, which is the largest, was built by the company at their own shops. This shear is driven by its own engine and has a cutter 6 ft. 6 in. long. It is used for boiler plate and taking the flanges off from the lengths of rails after they have been cut to length. The rolling mill is equipped with three heating furnaces, a 3,000-lbs. steam trip-hammer with a 28-in. cylinder, a 3,000 lbs. steam hammer with a 14-in. cylinder, a set of shears for cutting bar iron to lengths and a train of three-high rolls that are capable of rolling bars up to 6 in. × 1 in. or 9 in. × ½ in.

The material that is manufactured here embraces all the bar iron up to the size of the roller limit that is used by the road and the locomotive and car axles. These are issued to the several departments and shops, which are charged with everything delivered at a fixed rate.

Passing from the rolling mill, we come directly into the car shops. These shops consist practically of one long building divided by partitions into the several working departments. At one end is the planing-mill with its dry kiln for working the soft woods. It has the usual equipment of wood-working machinery, with blowers for conveying the shavings to the fire-room. This system of blower pipes is carried to all the other wood-working tools, so that the shop is kept clean with the minimum amount of manual labor. It may be noted here, also, that as the details of the freight equipment has been standardized, it is possible to keep a large reserve of material on hand ready for use, and that the introduction of the piece-work system has been greatly facilitated thereby. This system has been applied to all parts of the regular manufacturing, and is apparently satisfactory to both parties to the agreement.

Next to the planing mill is the machine shop for car work. It is unnecessary to recapitulate the tools in use in any of the several departments, as they are of the standard types common to all car shops. But there is some work done here, as we have already hinted, that is not usually found in railroad shops. For example, in the bolt and nut department, in addition to the usual work, all of the lag or coach screws in use upon the road are made. They are cut by the piece, the price varying with the size of the bolt or screw. It is in this shop that we are first brought into contact with the very elaborate system of overhead trolleys and floor tracks used for the transferring of material from tool to tool. The latter are narrow-gauge tracks of heavy flat iron that run the whole length of the shops, are provided with numerous turnouts and cross tracks, the latter being connected with the main line, as it were, by a flat-top turntable, upon which the flange of the wheels run, and which are therefore always in position for use, and which are so designed that they turn with the minimum amount of push on the part of the workmen. These tracks are used for conveying heavy or bulky material or large quantities for a distance. The overhead trolleys are of the single-rail type made of a piece of 3 in. × ½ in. flat iron on edge, over which a single-wheel trolley runs, and from which is suspended a Weston chain hoist. These are placed wherever there is a consecutive passage to be made of material from one tool to another. For instance, there is a crooked line that takes in the storage floor for axles, the wheel presses, axle lathe, and cutting off and centring machine for axles. The wheel borers are of course fitted with their own hoists. Here we again come into contact with tools built by the company, and this seems to have been done wherever the price of the foreign-built tool plus the duty on the same would render it advisable.

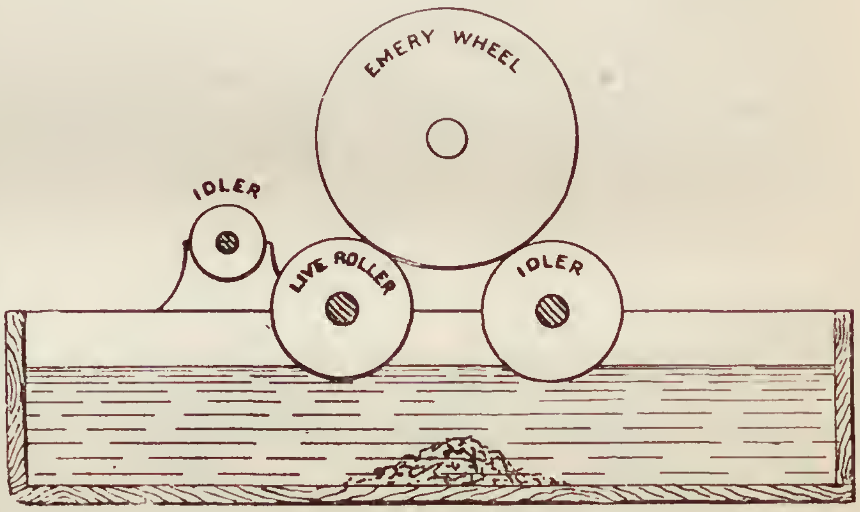
It is in one corner of this machine shop that we come upon the second industry, considering the rolling mill to have been the first, that is not a usual accompaniment of a railroad shop. All of the wire nails used by the road are made in this shop by four machines that have a capacity ranging from 70 to 250 per minute, according to the size of the product. The rods are, of course, bought from the manufacturers.

While dealing with the machine shop the subject of wheels and couplers is naturally suggested. Up to the present time the Grand Trunk Railway has adopted no type of the M. C. B. coupler, but is still using the link-and-pin coupler with the yoke connection for the spring. It is not expected that this state of affairs will continue for any great length of time longer, and they are expecting to swing into line. When they do, however, it is their intention to erect suitable foundries for turning out their own equipment. The cast-iron wheels used by the road are made at the company's foundry at Hamilton, and the steel-tired wheels are imported from Germany, and are of the Bochum type with Mansell retaining rings. A considerable number of 42-in. wheels are used. The axles, as we have said, are hammered from scrap on the premises, and are of the M. C. B. standard dimensions according to the car under which they are used.

Next to the machine shop, and with no dividing partition to separate the two, is the general wood working shop. Here the special tools made by the company also appear. Principal among them is a set of checking tools for checking belt rails, bolsters and the like at a single operation. As standards for car framing are so dissimilar, and as there is so little demand for tools of this type, there is nothing on the market that will do the work, hence these tools were home-made, drawings of which are now in our possession and will appear in a future issue. It may be added here that all of the checking for the pieces named is done at a single operation. Here, too, the overhead trolley is in evidence and serves to handle all of the heavy pieces, such as sills and bolsters, to and from the machines.

At the lower end of this shop is the cabinet shop, where all of the finer work is done, where doors and window sashes are made, and the veneer for head linings manufactured.

Next and last on the list as we pass down through the car shops is the erecting shop. Here there are three lines of tracks, upon two of which there is ample room for the erection of five 50-ft. cars, while the third is shortened by the space occupied by the plating and upholsterer's departments. In the plating room all of the brass fittings for the passenger cars are finished, the castings are made in the company's foundry, and are finished, buffed and plated in this room. The introduction of this department has effected a most marked saving in the cost of fittings. In one case a plate which formerly cost $1.25 is now made for about 22 cents; some spun shields of sheet brass that cost 90 cents to buy now cost 30 cents, and so the comparison might be carried through the whole range of car fittings, which is made to include not only door plates, bell cord hangers and fittings of a similar character, but locks, car lamps, headlight reflectors and parcel racks. Of course such a place as this cannot be without its own special devices, and one is the method of cleaning lamp burners. Any one who has tried to wipe one clean knows the trouble involved; boiling in water is but little better. Here a man hangs a half dozen on a wire and immerses them for a few moments in a kettle of hot lye, then they are dipped in a solution of nitric acid and sulphuric acid—only just dipped in—then plunged into and thoroughly swashed about in cold water, heated in a bath of boiling water, dropped into dry sawdust, from which they emerge as bright and shining as though they were just from the hands of their maker. The time occupied is about five minutes for the batch. The plating is done in the usual way, except in the case of headlight reflectors, where the reflector itself is made to serve for the bath. It is filled with the solution, which, after the plating is completed, is turned back into the bath. The shop



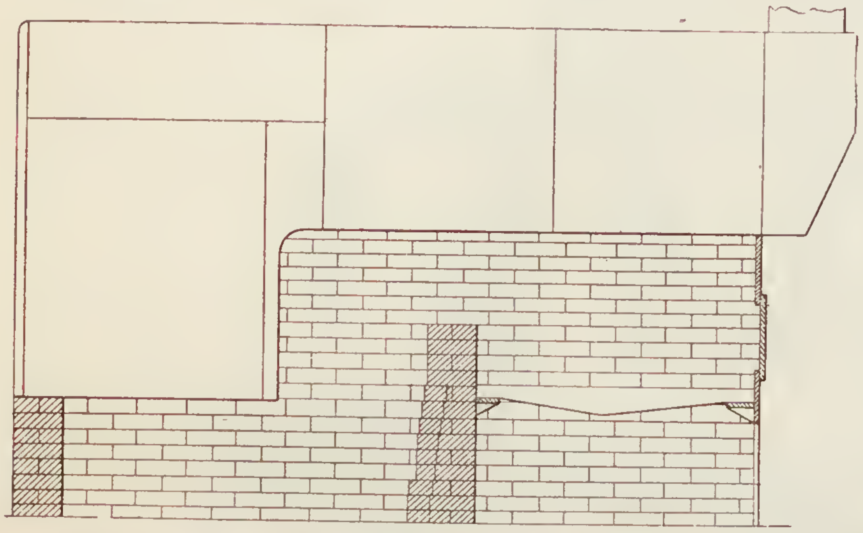
APPARATUS FOR REMOVING EMERY FROM POLISHING WHEELS.

is also fitted with a small gas furnace for making solder, and a little device for taking emery off from polishing wheels that saves time, labor and material. The accompanying sketch shows the whole affair. There is a live wooden roller that dips into a water bath, and on either side of it there is an idler. The wheel to be cleaned is set between two of the rollers, and is kept moist by the water on the live roller In this way the emery is washed off and falls to the bottom of the tray, whence it is removed, and after being dried and sifted is used again, while the leather is not injured by excessive wetting. In the upholsterer's room the car seats are made and repaired and soiled plush dyed.

The building in which the foregoing work is done is built without any post supports for the roof, but with a clear span from wall to wall, so that everything is free for the work to be done and the handling of the material used. The windows are large and set close together, and, what is of perhaps as much importance, are kept clean. The roof is white and

fitted with a wide monitor, so that the shop is well lighted, and even between the tracks, when all are occupied, there is not a suspicion of duskiness even upon a cloudy day.

South of this main building stands the repair shop, where all sorts and conditions of weaknesses are displayed. The building contains a line of six tracks, with posts supporting the roof between each two lines. It would be interesting to make a study of the inherent defects and strong points of the cripples sent to this hospital for rehabilitation, and if some car-builder would but make a systematic study of what is done in such a place, it would be a valuable contribution to the literature of car construction, and materially assist in the development of the car of the future, that should be like the deacon's one-horse shay, so equally strong in all its parts that nothing could give out first; and when the final collapse did come, the whilom car would seem to have been to the mill and ground. But in these shops there is the usual array of strong and weak constructions that are to be found in the "bone yard" of every trunk line. The shop requires no special tools, and it has none other than the usual complement of jacks and hoists. It seems, though, that far better provision is made for doing "bone-yard" repairs under cover than is usually the case, probably owing to the severity of the Canadian winters, where out-of-door work of this sort is rendered impossible for many months at a time.



ARRANGEMENT OF FURNACE FOR LOCOMOTIVE-FORM BOILERS.

There is a special building provided for doing the work of shrinking on of tires. This building is round, or rather sixteen sided, and contains a rack with gas and air-blast accessories for heating, and a crane standing in the centre of the building covers the whole floor with its boom. Here, too, are a couple of ordinary forges for doing the minor blacksmithing work connected with repairs and special jobs.

The paint shop is supplied with three trucks, each capable of holding eight passenger coaches, and well lighted both from the sides and roof.

Power is supplied to the car shops by eight locomotive-form boilers that have been converted into return tubular boilers by the very simple device of building a brick furnace under the shell and carrying the flue back and beneath the regular fire-box, which thus forms a most perfect combustion chamber, as shown by the accompanying sketch. These boilers are all fired with the refuse from the car shops, and the firing is done by hand. Six boilers are sufficient to supply all the steam that is needed, two being kept in reserve.

Some time ago,* in commenting upon the shops of the Philadelphia & Reading Railroad, we called attention to the remarkable freedom from sulphurous gases that prevailed in the blacksmith shop, due to the use of suitable hoods over the forge fires. This is even more noticeable in the shops under consideration, in that the natural ventilation of this building is poor; and yet there is not the slightest trace of sulphur about the premises. The hoods are built of brick and entirely cover the forge, and yet are high enough to permit of entire freedom of action on the part of the smith. The blacksmith shop also has a number of oil-heating furnaces that are used for special work, burning crude oil with a Burns burner. The power for the blacksmith shop is supplied by a portion of an old inside-connected locomotive. The frame has been cut off just back of the main driving-axles, the links removed, and the eccentric-rods connected direct to the lower arms of the rockers. It is the last step in the utilization of an old piece of machinery that has outlived its original purposes. Even one of the driving-wheels has been retained in position, the rim grooved and a V-belt applied to drive the shafting. This utilization of old locomotive parts is current practice here, especially in the matter of boilers, where those condemned for the higher pressures and greater strains of locomotive service are utilized for stationary work.

The Grand Trunk might almost be called an English railroad transplanted to American soil. Many of the officers received their training in the old country, and it is not strange that the practice of the road should be tinged with English ideas. Indeed, it is to be wondered at that these ideas are not more pronounced than they are. English machinery naturally takes the place of American if it can be bought for a lower figure, for this price has the twofold influence of actual cost and the duty, which is an *ad valorem* one, and places a practical embargo upon goods made in the United States. The first shop where this appears in a pronounced shape is the boiler shop, which, with the exception of a Worthington hydraulic pump, is entirely equipped with English tools. There are the well-known Tweddle hydraulic riveters, both stationary and portable, hydraulic punches by the same firm, and a very fine planer with a travelling head that is reversible, so that it cuts in both directions, for planing the edges of boiler sheets, the whole being capped by a fine hydraulic crane of five and 10 tons capacity of the Tweddle design that has a lift of 27 ft. in the clear from the floor and a radius of 22 ft.

In the machine shop the same condition prevails, the heavier machinery having nearly all been purchased in England or Canada. There is one noticeable feature about this foreign built machinery that American manufacturers and American users would do well to imitate. It is the care with which shields or coverings are placed over all moving parts that are in any way likely to catch the clothing or person of the workman. With us it is a regrettable fact that gearing is allowed to run loose, as it were, without even the faintest pretext of a covering, so far as forming a portion of the machine is concerned; and it may be said that it is only occasionally that even a railing is erected that serves to prevent the unwary from falling into the trap that seems to have been set for them. With the English and German machines, on the other hand, every precaution is taken to guard against such accidents, which results not only in gaining the object aimed at, but in giving the tool a neater appearance.

The erecting shop consists of 40 pits, with no provision for overhead hoisting, and at one end only is there an arrangement for hoisting engines for placing the wheels beneath them. These 40 pits are placed on either side of the shop, and are separated by a shallow pit over which a transfer carriage is made to travel. The machine shop is a counterpart of those of most railroad shops where the requirements have to a certain extent outgrown the capacity, and the tools are somewhat crowded. There are a few special tools that have been built on the premises, among them the link grinding machine that was illustrated and described in our issue for May, 1895. This tool grinds the link and block to a true radius after they have been case-hardened, and does its work so accurately that blocks move with perfect freedom from one end of the link to the other, whether in their proper position or reversed.

The shop is also showing evidence of the introduction of compressed air, and a number of hoists running on overhead tracks similar to those in use in the car shops are employed. The compressed air is supplied by a compressor made on the premises from old cylinders that were useless for other purposes.

Contrary to the practice of many roads, the Grand Trunk make all of their own castings both in iron and brass. Both foundries are fitted for both hand and machine moulding. There can be nothing very novel in the methods pursued in variation from those employed elsewhere except in the details of the arrangements and the construction of the moulding machines. After a careful investigation of the machines now upon the market, it was decided that the peculiar conditions of work required a modification of the machines offered; and so, while there are some machines in use that were purchased direct from the makers, the road has built others with some modifications which adapted them to their work, and which we will illustrate in a future issue.

The tour of the shops having been completed, it now remains to note the outside attachments that are a part and parcel of the whole, but do not necessarily belong to the manufacturing departments.

We have said that the management of the road is tinged with English practice, and this appears most prominently, perhaps, in the use of a running shed in place of a roundhouse. There is a cross-shaped building on the premises with a turntable in its centre and tracks leading radially off therefrom that is to all intents and purposes a roundhouse, but it is old and low, and would not be rebuilt in its present form were it to be destroy-

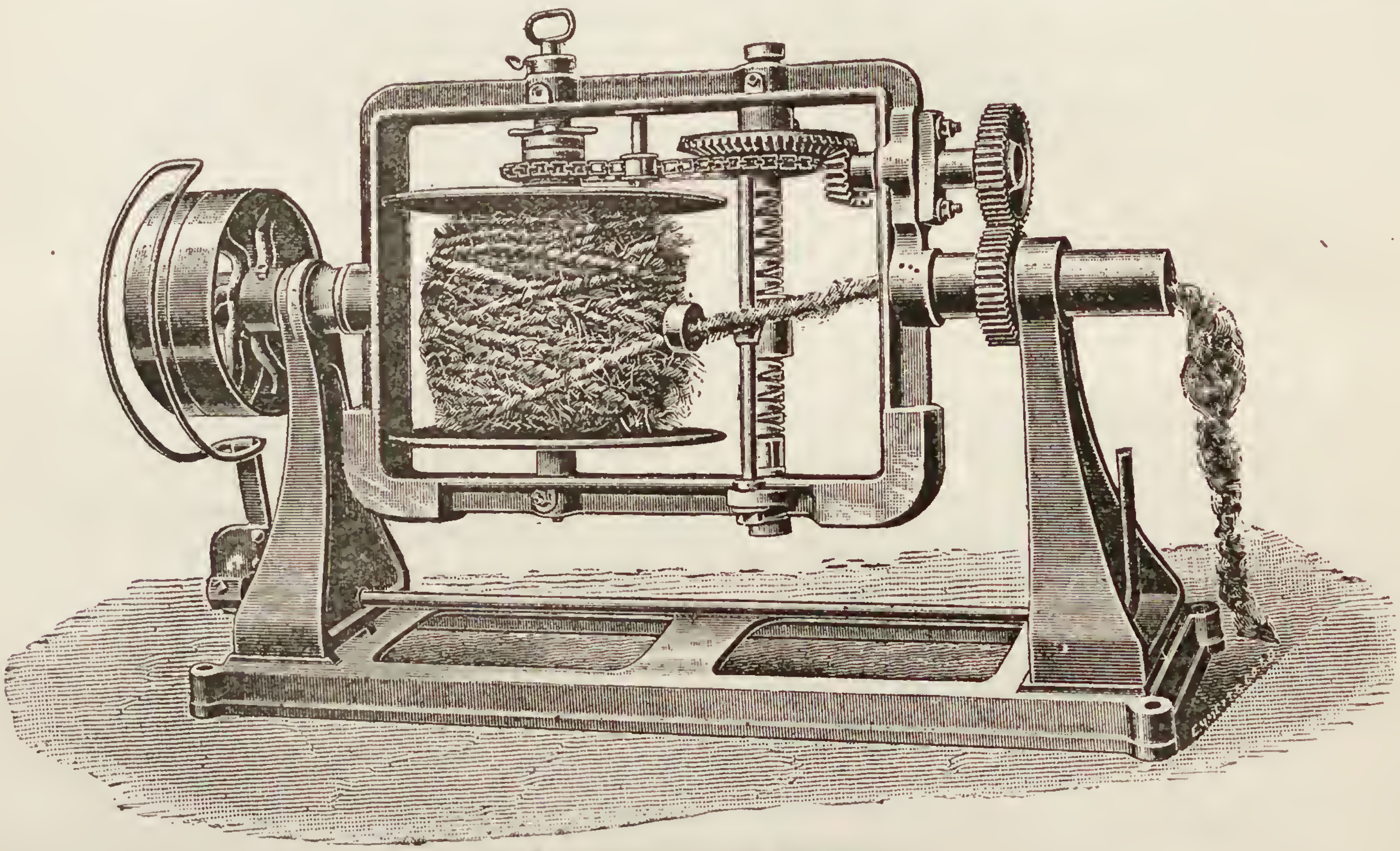
* See American Engineer and Railroad Journal for November, 1893

ed. The real locomotive house is a fine long running shed with four tracks running the entire length, having pits that are well drained and heated with steam. Overhead there is an inverted trough for catching and carrying off the smoke, and which is hipped up at intervals of about 35 ft. to stacks for carrying off the smoke. On the occasion of our visit the building was nearly full, but there were no signs of any trouble from the smoke, and we are told that there is none in the winter, when everything is closed. Speaking of the desirability of the running shed in comparison with the roundhouse, the management are most emphatic in their preference for the former. It is claimed that where engines are run first in first out, that the rotation is natural, that they are more easily handled, and that in case of fire the danger of heavy loss is reduced to a minimum. Such testimony is more valuable coming from this source than it is from the English roads, in that the roundhouse is still extensively used on the Grand Trunk, and the present running shed was preceded by a roundhouse.

delivery of lectures, the institution of classes, and the providing of specimens and drawings."

Any employée of the company may become a member upon the payment of dues that are 10 cents a month, and this entitles him to draw books—except books of reference—from the library and retain them for 14 days; to have access to the reading-room and to all the privileges of the building, which includes hot and cold baths, the use of the lecture hall at noon for lunch, the lectures and entertainments. This lecture hall is a large room, with tables and benches that can be used for lunching, and a heating chamber, in which the lunches of the men are warmed for them. At one end of the hall is a stage well equipped with stock scenery, and upon which the dramatic ability of the members has a chance to display itself. At present there are about 700 members, and the records show that something more than 16,000 volumes were drawn during the year ending December 31, 1894.

From what we have written, it will be understood that these



HAY-BAND SPINNING MACHINE.

Among the outside attachments is the fire service. There is a regularly organized fire brigade with an engineer in constant attendance, and hose carts that are manned by employés in the shops when an alarm is given. They are regularly drilled, and at intervals about the buildings and yards there are signal stations from which notice of a fire can be sent to the headquarters of the company's brigade as well as to that of the city fire department. Water is supplied by mains under pressure, so that no fire engine is needed, and a hose attachment to a hydrant is all that is required in order to throw a powerful stream.

Back of the hose-room is an accident-room, with all of the appliances for dressing wounds and caring for the patient. A telephone connection enables a physician to be called at once, and arrangements have been made with several to respond to calls, so that one is always available. In connection with this department there is an insurance society, in which every employé is obliged to take a policy. The rates are something less than $30 a year for $1000, and policies are issued for from $250 to $2,000. The physical examination for this is practically the same as that of the regular line companies.

A valuable adjunct to the shop is the reading-room and library; it is technically known as the Grand Trunk Railway Literary and Scientific Institute, and is supported by a grant from the railroad company and dues from the members. A fine room is furnished by the company, in which is placed a library of 6,467 volumes, comprising works on architecture, electricity, engineering, mathematics, agriculture, geology, natural history, hygiene, astronomy, natural philosophy, history, biography, travels, poetry, novels, books of reference, magazines and reviews. It was founded in 1857, and in 1871 received a corporate charter. The object, as laid down in the constitution, is "to supply its members with the means of instruction in science, literature and the arts by the establishment of a reading-room and library, for the use of its members, the

shops occupy the unique position of being a little world by themselves, cut off to a certain extent from the supplies of the manufacturing countries, and thus compelled to depend upon its own resources to satisfy its own wants. The officers have, therefore, been forced to design and construct many machines that under other circumstances would have been bought in the open market. In the course of our description we have alluded to a few of these machines, of some of which we shall publish engravings and descriptions in future issues.

HAY-BAND SPINNING MACHINE.

The illustration given herewith represents a machine for spinning hay and straw bands used principally in the foundry for core making, and also extensively for packing ironmongery, furniture, etc. In the old method of making bands the twist is put in by the turner using a cranked handle with a hook at the end, while the core maker strings or "roves" the hay or straw together. This has three important drawbacks. The first is the slowness of the operation—say, 60 or 70 turns per minute being good work to maintain. The second defect is that the length of the bands thus produced is limited, 30 yds. being a good length (and this is not always available in a foundry), and therefore to cover a fairly large core it requires several lengths. The third demerit is that the bands cannot be twisted hard. A soft band or a band soft in places is objectionable, because when the metal is poured, and especially with deep castings having a great pressure at the bottom, the band does not support the core, but is crushed in to some extent, making the interior of the bore rough and irregular. These inconveniences are, it is claimed, altogether obviated by making the bands by the machine represented, one of the merits of which is that it only requires the services of one

man, who can make bands from ½ in. up to about 1½ in. diameter, the thickness being regulated by the amount of material the operator passes through the machine. The frame makes about 140 revolutions per minute. As will be seen, the saving in floor space is a consideration, no rope-walk being required; also the band can be readily removed from the machine without unwinding. Further particulars will be readily supplied by the maker, Mr. James Pollard, Atlas Works, Burnley.—*The Mechanical World.*

TANK LOCOMOTIVE FOR THE NEW YORK AND BROOKLYN BRIDGE.

H. K. Porter & Co., of Pittsburgh, Pa., have recently built some tank locomotives for use on the New York and Brooklyn Bridge that are heavier than any that have heretofore been used in that place. As the work done by these locomotives is switching work of the severest kind, it is necessary that they should be built in the strongest and most substantial manner. Accordingly the frames used on these engines are like those used upon one size heavier locomotive as ordinarily built by these makers.

One of the peculiarities of the engine is that upon the right-hand side a pump is placed instead of an injector. This was done as a precautionary measure to insure the positive feeding of the boiler in case of an accident to the injector due to the jarring over the frogs or for any other reason. In the suction-pipe of the pump and just beneath the running board there is placed a small cast-iron box, into which a boiler-cleansing compound can be introduced through an opening that is usually closed with a gas-pipe plug. The compound is thus pumped into the boiler with the first flow of water. A charge put in once a week, and a blowing down of the boiler from a full condition to the first gauge just before the cleanser is pumped in, serves to keep the boiler free from scale, which would otherwise be a carbonate of lime from the water used. This is about all the work that the pump is called upon to perform; the injector on the left-hand side being ordinarily used for feeding.

Beneath the foot-plate, on the right-hand side, there is a cast-iron box of about 2 cub. ft. capacity, with a drain pipe supplied with a globe valve. This box is used to catch the waste from the gauge-cocks, the relief from the pump, and the overflow from the injector, so that there is no slopping of water about the depot, and is emptied when the engine is run over the pit.

The pony trucks under these engines are fitted with a new device, whereby on curving a pair of rollers that carry the weight are made to roll up an incline, with a constant tendency to return and draw the truck back into its normal position. It is expected that engines of this type will be adopted as a standard for the bridge work, which will be more severe than ever after the present terminal alterations are completed.

The following is a list of the principal dimensions:

GENERAL DIMENSIONS.

Type of locomotive, four driving-wheels, with two-wheel front truck and two-wheel rear truck.
56½ in. gauge track.
Cylinders, simple, not compound.
Anthracite fuel.
Total weight, 79,900 lbs., with 57,400 lbs. on the truck-wheels.

Rigid wheel base	5 ft.
Total wheel base	18 ft. 11¾ in.

Length over all, not including drawheads, 24 ft. 1 in.; or, over drawheads, 28 ft.

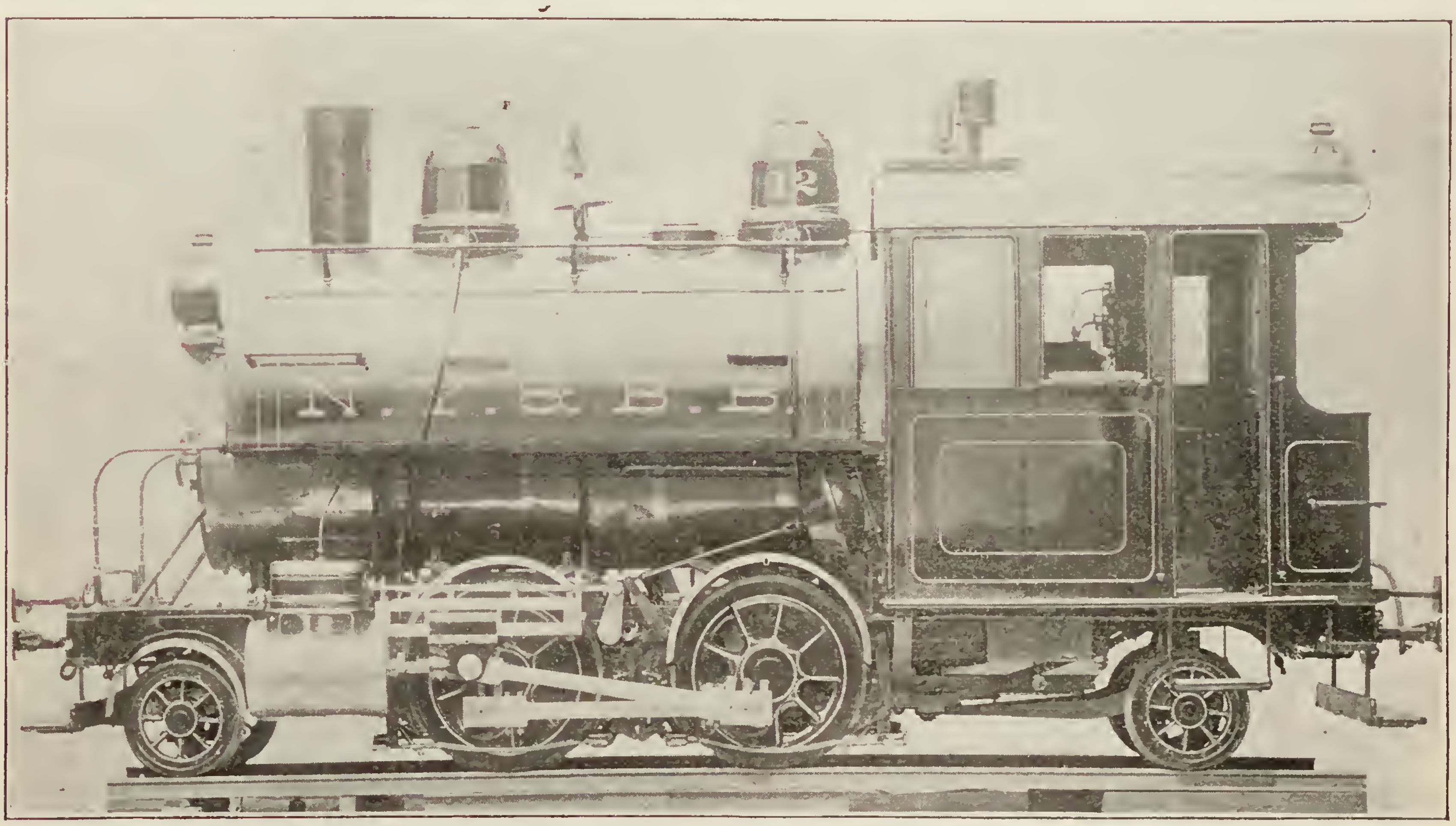
Extreme height of stack above rails	12 ft. 7 in.
Heating surface, fire-box	61.5 sq. ft.
" " tubes outside	625.0 sq. ft.
" " total	
Grate area	15 sq. ft.

WHEELS AND JOURNALS.

Drivers, number	4
" diameter	42 in.
Truck-wheels, diameter	26 in.
Journals, driving-axle, size	7 in. × 7⅝ in.
" truck " "	3¾ in. × 6 in.
Main crank-pin, size	4 in. × 5½ in.

CYLINDERS.

Cylinders, diameter	14 in.
Piston stroke	18 in.
Balanced slide valve with relief valve.	
Type of boiler	Straight top.
Working steam pressure of boiler	160 lbs.
Number of tubes	166
Outside diameter of tubes	1¾ in.
Length of tubes over sheets	99 in.
Fire-box, length	59 in.
" width	36⅝ in.
" depth, front	43½ in.
" " back	38 in.
Kind of grates	Water-tube and wrought-iron bars.
Diameter of smoke-box	48 in.
Length " "	47 in.
Taper stack.	
Capacity of water-tank	1,000 galls.
Coal capacity	1,750 lbs.



TANK LOCOMOTIVE FOR THE NEW YORK AND BROOKLYN BRIDGE.

NAVAL AND MARINE NOTES.

A Naval Experimental Tank.—The Chief Naval Constructor will, it is said, urge upon the next Congress the need of an experimental tank for testing the resistance of various forms for ships, models of which will be built Such

tanks have been constructed and are in constant use in the Navy Departments of England and France and in some private shipbuilding yards on the Clyde, where their commercial value, it is said, has been fully demonstrated. The British Admiralty have had for several years three or four skilled officials constantly on duty at the experimental tank at Haslar, and no new design is laid down until full trials have been made of the model and accurate information obtained upon which the future performance of the vessel may be reliably predicted. An appropriation of $100,000 will suffice for the complete installation of a plant of this kind, including all necessary structures.

Tests of Creusot Armor Plates.—In April last the Royal Navy Department of Sweden awarded a contract for armor plates to Messrs. Schneider & Co., of Creusot. The plates are intended for the new vessel, the *Oden*. The one that was recently tested was 2 metres (6.56 ft.) long by 1 metre wide (4.92 ft.), with a thickness of 0.25 metre (9.84 in.). According to the terms of the contract, it was called upon to sustain three shots from a gun having a calibre of 15 centimetres (5.9 in.) throwing a chrome steel projectile forged at Finspong, and meeting the requirements of the Swedish Navy ; the same to weigh 99 lbs., and to have a velocity at the point of impact of 1,850 ft. per second. Under these conditions no portion of the shot or the plate was to be forced through the target ; the first shot was to produce no cracks, and the other shots must detach no pieces that would leave the crew exposed. The three shots were fired into the apeces of an equilateral triangle having sides equal to about 3½ calibres and 4.8 ft. from the side, located in the centre of the plate, the base being horizontal. None of the three shots produced any crack in the plate, each one having rebounded to from 14 ft. to 18 ft. After the trial the plate was removed from the target to which it had been fastened by 12 bolts, and only a slight bulging and crack was visible at the back. The plates thus greatly exceeded the specifications, and the shot which suffered only a very slight distortion evidenced the excellent quality of the work done on projectiles at Finspong.—*Le Yacht*.

Three New Torpedo-Boats.—The act of Congress authorizing the construction of the three new boats provided that only one if possible was to be built on the Pacific Coast, one on the Mississippi or its tributaries, and one on the Gulf of Mexico, and the required speed was to be 26 knots, and the limit of cost was $175,000, of which the Navy Department reserved $25,000 for armament, making the real limit $150,000.

Bids were received from the Union Iron Works, of San Francisco, $175,000, the Wolf & Zwicker Iron Works, Portland, Ore., $168,700, and Moran Bros. Company, of Seattle, $163,350. No bids were received from the Mississippi or Gulf of Mexico region. The Herreshoffs, of Bristol, R. I., offered to build one or all three of the boats at $144,000 each. They were, however, to be built on plans which the company submitted, whereas the other bids were on the Navy Department plans. It is not said whether these prices included the armament or not. The New York *Sun* reports that a board, comprising Commander Converse, Naval Constructor Clapp, and Lieutenants Fletcher and Smith, convened at the torpedo station at Newport on September 16, to prepare a report on plans submitted by the Herreshoffs for torpedo-boats, and on which these noted builders submitted the lowest bids in the recent contest. It is understood that the Herreshoff plans, aside from the low bids made, are quite acceptable to the Navy Department, and that it is to determine the value of one or two innovations and minor changes suggested by the Herreshoffs that the special board was convened.

The following list gives the names, the speeds of various torpedo-boats, and that of their builders, from which it will be seen that 26 knots now cannot be regarded as being extraordinary :

Hornet,	by Yarrow	27.6	knots.
Havoc,	" "	27.	"
Daring,	" Thorneycroft	29.268	"
Ardent,	" "	29.182	"
Adler,	" Schican	27.4	"
Chevalier,	" Normand	27.22	"
Boxer,	" Thorneycroft	29 3	"
Sokol (Hawk),	" Yarrow	30.285	"

PERSONALS.

Mr. H. M. Norris, whose name is more or less familiar to our readers, has accepted the important position of Superintendent and Mechanical Engineer of the Riehle Bros. Testing Machine Company, engineers, founders, and machinists, Ninth Street above Master, Philadelphia, Pa. Mr. C. E. Buzby, who for a number of years has been their Superintendent, is about to retire from active business, but will remain with them in the capacity of consulting engineer.

E. E. Keller, of the Westinghouse Machine Company, has just returned from Europe, where he obtained for his company all American rights in the Parsons steam turbine. It is just what its name implies, a turbine or rotating wheel, like a water-power wheel, only that it is driven by steam instead of by water. The steam is transmitted direct from the boiler against the turbine, striking it with great force. The turbine rotates and is connected by shafting with the electric generator, which is to furnish the power desired. It is claimed for this kind of turbine that each 15 lbs. of water in the boiler will generate 1 electric H.P., which is a very remarkable efficiency.—*Pittsburg Despatch*.

Mr. L. B. Sherman, for many years connected with the *Railway Review*, of Chicago, has been appointed Western Manager for *The Official Railway Equipment Guide* and *The Pocket List of Railroad Officials*. Mr. Sherman assumed his new duties on September 1, 1895, with headquarters 425 Rookery, Chicago.

EDWARD F. C. DAVIS.

At a meeting of the Council of the American Society of Mechanical Engineers, held August 26, resolutions were adopted expressing the respect and regard of its members for the late President, whose sudden and untimely death has been so deeply mourned. "His wise and mature judgment," it is said in the resolutions, "his business and professional knowledge, his conservative yet energetic counsel, and his courteous consideration for others, had made him one from whose administration for the Society's affairs the highest hopes had been entertained."

PROCEEDINGS OF SOCIETIES.

Master Car-Builders' Association.—The Secretary has published the result of the informal ballot on the modified recommended practice in grab-iron or hand-hole location. There were 653 affirmative and 320 negative votes, but as there are 1,477 possible votes in the association, it is impossible to say from this test ballot what modification can be adopted in 1896 in the recommended practice for hand-holes.

The Secretary has also announced the following subjects and committees for the Convention to be held in June, 1896 :

1. *Metal for Brake-shoes, Laboratory Tests.*—S. P. Bush, D. L. Barnes, John W. Cloud. In making final report this Committee to confer with the Executive Committee of the Committee on Road Tests of Brake-shoes of 1895—R. H. Soule, A. E. Mitchell, W. S. Morris.

2. *Automatic Couplers.*—To advise what changes may be desirable in the standard size of Master Car-Builder automatic coupler shanks, and to recommend a standard yoke or pocket strap for rear-end attachment to cars—J. M. Wallis, R. D. Wade, T. G. Duncan, A. E. Mitchell, William Garstang, Thomas Kearsley, J. T. Chamberlain.

3. *Mounting Wheels.*—To review the subject of mounting wheels and the standard check gauge, together with the standard distance between wheels—J. N. Barr, A. M. Waitt, J. H. McConnell, R. E. Marshall, J. C. Barber, Thomas Sutherland, Pulaski Leeds.

4. *Passenger Car Ends and Platforms.*—To consider what improvements may be made in the construction of passenger car ends and platforms for increased strength in ordinary service and in emergencies—E. W. Grieves, F. D. Adams, J. J. Hennessey, C. A. Schroyer, M. M. Martin, Samuel Porcher, T. A. Bissell.

5. *Axle, Journal-box, Bearing and Wedge for Cars of* 80,000 *lbs. Capacity.*—To propose standards with detail drawings of same—E. D. Nelson, William Forsyth, J. E. Simons, J. H. Rankin, John Hodge, F. W. Chaffee, George Gibbs.

6. *Metal Underframing for Freight Cars.*—To discuss the extent to which metal may be used with economy and advantage ; also the best forms—R. P. C. Sanderson, D. L. Barnes, Robert McKenna, J. D. McIlwain, Clement Hackney, John Player, J. R. Skinner.

7. *Location of Air-brake Cylinders on Freight Cars.*—Having in view easy access for cleaning and repairing—James Macbeth, B. Haskell, A. C. Robson, Robert Gunn, F. B. Griffith, Joel West, H. C. McCarthy.

8. *Freight Car Doors and Attachments.*—To inform the Association as to the latest improvements and the best practice—

F. H. Soule, B. E. Thomson, Charles Waughop, J. J. Casey, Thomas Fildes, A. J. Cromwell, W. J. Robertson.

9. *Handholds and Height of Drawbars.*—To review the recommended practice in regard to handholds and to advise whether greater uniformity can be secured in their location on cars of different types or classes, and to advise what will best conform to the requirements of the law. Also to advise what shop or repair practice will be most desirable in order to have the height of drawbars at all times in conformity with requirements of law—H. S. Hayward, Tracy Lyon, L. B. Paxson, S. A. Charpiot, J. W. Marden, S. Higgins, S. A. Crone, W. A. Nettleton, C. A. Schroyer, J. Mackenzie, A. E. Mitchell.

10. *Uncoupling Arrangements for Master Car-Builders' Automatic Couplers.*—To consider whether a standard uncoupling device is practicable and the details thereof—G. L. Potter, Samuel Irvin, G. W. West, C. E. Turner, R. M. Galbraith, G. B. Sollers, R. C. Blackall.

The Institution of Civil Engineers.—Mr. James Forrest, the Secretary, has issued from his office in Great George Street, Westminster, London, S.W., a circular giving the subjects and conditions regarding papers for which prizes are offered by the institution. This circular states that the Council of the Institution of Civil Engineers invites original communications on the subjects included in the following list, as well as on any other questions of professional interest. This list is to be taken merely as suggestive, and not in any sense as exhaustive. For approved papers the Council has the power to award premiums, arising out of special funds bequeathed for the purpose.

The Council will not make any award unless a communication of adequate merit is received, but will give more than one premium if there are several deserving memoirs on the same subject. In the adjudication of the premiums no distinction will be made between essays received from members of the Institution or strangers, whether natives or foreigners, except in the cases of the Miller and the Howard bequests, which are limited by the donors.

LIST.

1. The most economical methods of handling large masses of excavation, as exemplified in modern canal construction.
2. The measures necessary for the improvement of canal navigations.
3. The methods adopted in carrying out large dock and harbor works, with descriptions of the plant employed.
4. The appliances for dredging and for removing rock in deep water, with details of the time occupied in the various operations.
5. The application of compressed air, steam and hydraulic power to rock-drills.
6. The construction, equipment, and working of light or economical railways of a permanent character.
7. The design and construction of railway carriages, having reference to (*a*) lavatory accommodation; (*b*) provision for refreshments; and (*c*) sleeping arrangements.
8. The use of compressed air in subaqueous tunnelling.
9. The modern methods of pumping compared as to cost and efficiency.
10. The use of steel in the construction of large water-tanks.
11. The employment of storage-reservoirs in irrigation and in the conservation of rivers.
12. The purification of sewage by precipitation, filtration, electrolytic, bacteriological, and chemical processes.
13. The use of ash-bin refuse in towns for the production of steam.
14. The purification of large quantities of water after its use in manufactories.
15. The methods of enriching coal-gas and their effect on its calorific and illuminating values.
16. The production and enrichment of water gas.
17. The methods of conveying and of using natural gas.
18. The utilization of heat (*a*) generated in the compression of air and other gases; (*b*) carried away by steam engine condenser-water; and (*c*) contained in boiler-furnace flue-gases.
19. The methods of condensing steam by the use of moderate quantities of water.
20. The methods of removing moisture from steam, and of reducing losses by radiation from steam pipes.
21. The production and use of superheated steam.
22. The theory and development of the compound steam-turbine.
23. The recent development in gas-engines and oil-engines, including a comparison of the relative merits of the several cycles, with reference to "after-burning."
24. The application of oil and gas-engines to tractive purposes on common roads and on tramways, and to the propulsion of vessels.
25. The design and construction of large turbines.
26. The methods of testing the lubricating values of oils, greases, etc.
27. The comparative merits of blast and reverberatory furnaces.
28. The influence of carbon on iron.
29. The magnetic properties of iron and steel.
30. The manufacture of steel for structural purposes.
31. The strength of steel shafts, tubes, and cylinders.
32. The mining of thin seams of coal.
33. The underground arrangements in collieries.
34. The influence of coal dust in contributing to colliery explosions.
35. The efficiency of centrifugal fans for forced draft and for the ventilation of mines.
36. The drainage of mines by pumping and by tunnelling.
37. The extraction of metals from their ores by electrolytic processes.
38. Argentiferous lead smelting in water-jacketed blast-furnaces.
39. The methods of gold-mining in California.
40. The occurrence, production, and uses of (*a*) asbestos, (*b*) arsenic, and (*c*) mercury.
41. Aluminium, its manufacture, properties, uses, and alloys.
42. The metallurgy of chromium, molybdenum, and other rare metals, and their use in the manufacture of steel.
43. The design, construction, erection, and working of modern stamp mills.
44. The machines for raising mineral tailings, as lifting-wheels, pumps, dredgers, etc.
45. The most suitable steam-power equipments for electric-light stations.
46. The utilization of electric-lighting plant during hours of small demand.
47. The utilization of electrical energy in the form of heat.
48. The regulation of electric pressure in large lighting circuits as carried out at the engine, the dynamo, or the exciter.
49. The theory and practice of the transmission of power by alternating currents.
50. The use of electrical motors for driving machines in textile factories and in engineering workshops.
51. The first cost, facility, and economy of operation of electrical traction on railways with heavy trains and on tramways.
52. The construction and working of electrical lifts and cranes.
53. The electrolytic action of return currents in electrical tramways on gas and water-mains, and the best means of providing against electrical disturbances.
54. The most suitable alloys for the working parts of pumps for lifting corrosive liquids from mines, etc.
55. The methods of preventing or arresting the corrosion of hydraulic rams of large diameter.
56. The use of the die-press in workshop operations.
57. The modern rolling-mills of the United States.
58. The appliances used in the manufacture of smokeless powder.
59. The transport, storage, and manipulation of grain.
60. The different systems of refrigeration, and of appliances for the storage and preservation of food produce.
61. Brine-pumping and the manufacture of common salt.
62. The present limits of speed at sea.
63. The most recent types of (*a*) passenger and mail steamers; (*b*) cargo steamers.
64. The relative advantages of single screws, of twin screws, and of triple screws in large vessels.
65. The use of electrical machinery for lighting and the transmission of power in warships and in the mercantile marine.
66. The best position for torpedo discharging tubes on large vessels, with a fixed direction or trainable.

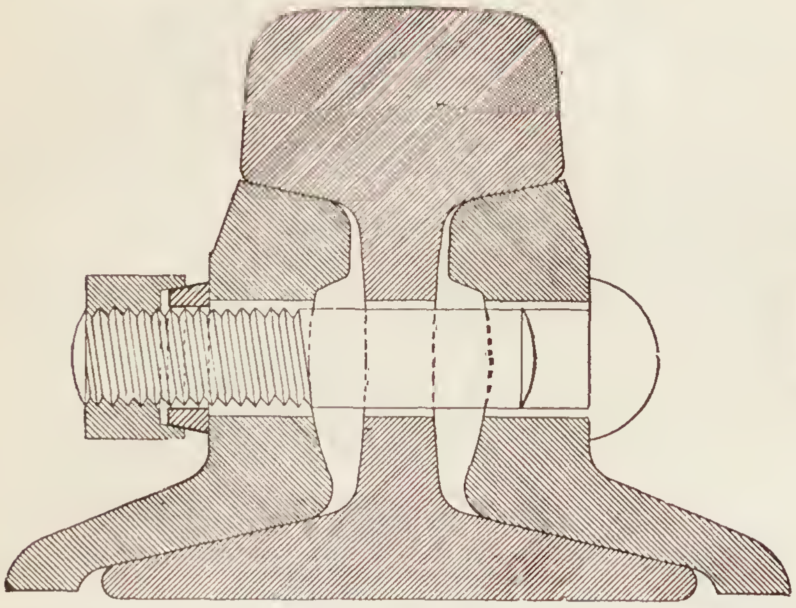
INSTRUCTIONS FOR PREPARING ORIGINAL COMMUNICATIONS.

In writing these essays the use of the first person should be avoided. They should be legibly transcribed on foolscap paper, on one side only, leaving a margin on the left side, in order that the sheets may be bound. Every paper must be prefaced by an abstract of its contents not exceeding 1,500 words in length.

Illustrations, when necessary, should be drawn on tracing-paper, to as small a scale as is consistent with distinctness, but in no case should any figure exceed 6½ in. in height. When an illustrated communication is accepted for reading, a series

of diagrams will be required, so drawn and colored as to be clearly visible at a distance of 60 ft. These diagrams will be returned.

Papers which have been read at the meetings of other societies, or have been published, will not be accepted. According to the by-laws every paper presented to the Institution is deemed to be its property, and may not be published without the consent of the Council.



SECTION OF RAIL WITH THE KLEMAN NUT-LOCK APPLIED.

The communications must be forwarded to the Secretary, from whom any further information may be obtained. There is no specified date for the delivery of manuscripts, as when a paper is not in time for one session it may be dealt with in the succeeding one.

Manufactures.

THE KLEMAN NUT-LOCK.

The Kleman nut-lock consists of a combination nut having a countersunk cavity on its inner face, and an annular tapering divided washer fitted in the countersunk recess, the washer being made of a sufficient depth that when the nut is tightened on the bolt, the washer will project from the recess and bear against the plate or bearing.

The washer is oil-tempered and made of the best spring steel. In applying the nut-lock to use, the washer is put on the bolt against the bearing, and then the nut is screwed home upon the plate until its countersunk cavity encircles the washer. Further tightening the nut will compress the washer which is around the bolt, and will press against the bearing applied and cause the nut to lock on the washer, as will be readily understood by reference to the cuts.

The nut itself does not bear against the bearings or plate applied, as the outer face of the washer does not extend to the base of the cavity. In the nut space is allowed for expansion and contraction of the bolt.

The bearing against the plate is taken entirely by the washer, and as this is divided it will yield so as to fit easily against the plate, and afford a perfect bearing, even though the plate be irregular in shape, whereas if the nut should be allowed to bear against the plate such evenness of bearing is not always attainable.

This nut-lock has been thoroughly tested in various ways, when it has been subject to vibration and is reported to have shown its excellence and superiority.

The bolt from which our engraving was made came to us with a wooden block between the head and nut, the surface of the block being somewhat beveled, to show that the washer will take a bearing on such a surface as well as it will on one which is square with the axis of the bolt. The block was omitted in our illustration to show the form of the washer and the cavity in the underside of the nut.

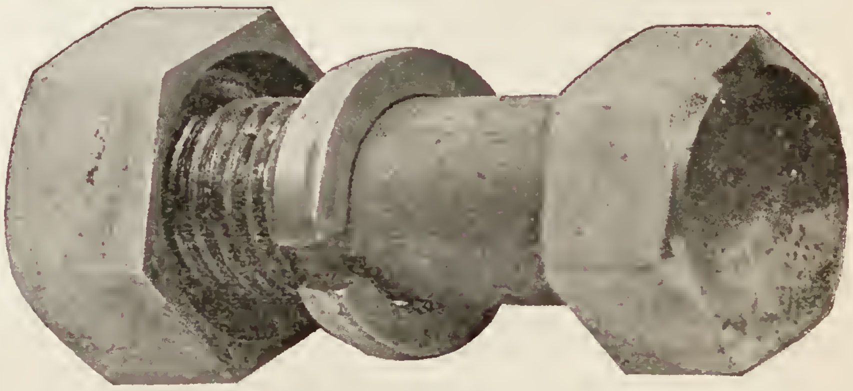
The Allison Manufacturing Company, of Philadelphia, have undertaken its manufacture, and are prepared to fill orders of any magnitude.

THE DAYTON GAS ENGINE.

The gas-engine illustrated in this connection is one that is being made by the Dayton Gas-Engine Manufacturing Company, of Dayton, O. In general appearance it is very similar to those of other makes, the difference lying in the adaptation of fundamental principles. An arrangement that will strike the eye of the observer at once is that the working parts, such as the valves, etc., are clustered on the top of the cylinder, instead of being placed on one side or attached to the cylinder head. The valves are of the poppet type, and each valve is worked positively and directly from the cam-shaft by means of a separate stem that has double bearings, keeping it in perfect alignment.

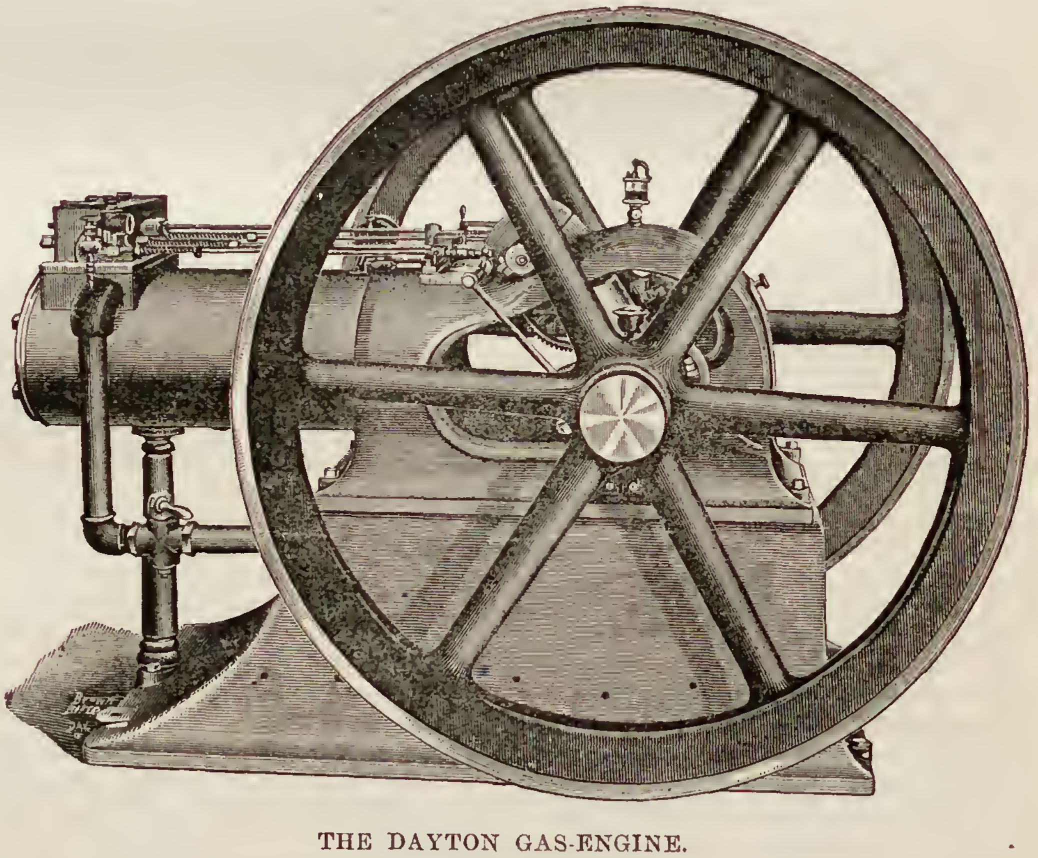
No carbureter or vaporizer is used, but the gasoline is taken directly from the tank, which is lower than the inlet. This is done without the use of intricate pumps or other devices that could tend to complicate the working of the engine.

The engine is also provided with a covered crank-shaft, as shown in the engraving, and surrounding objects are thus protected from oil that may be thrown from the bearings, while the engine itself is protected from an accumulation of dirt and grit.



THE KLEMAN NUT-LOCK.

The mixture of air and gas is fully accomplished before they enter the cylinder, and the cylinder and the explosion-box are both water-jacketed without having any packing whatever between the former and the water chamber. The chief feature of the engine is that it is built upon the principle of regulating by governing the explosive mixture rather than by governing the frequency of the explosions. It thus becomes possible to regulate the speed of the engine, so that in case it is desired to throw a belt on or off from the engine-pulley, or do any similar work, the speed of the engine can be reduced almost to stopping, and the engine speeded up again without



THE DAYTON GAS-ENGINE.

actually coming to a stop. It is also arranged so that the speed can be increased or decreased at will while running, when it will continue to run at the new speed until a further change in the adjustment is made.

Either gas or gasoline can be used in the engine, and with the same apparatus ; indeed, it is possible to shut off the supply of one kind of fuel and turn on the other while the engine is in motion. In regard to consumption, it is said to be from 16 to 20 ft. of natural gas per H.P. per hour, or three-fifths of a pint of gasoline.

In testing these engines they are not bolted or in any way fastened to the floor, and the full load is suddenly thrown on and off with no difference in the working, except in the variation in the number and intensity of the explosions. The engine is ordinarily built for electric ignition, but can be changed to tube ignition.

IMPROVED AUTOMATIC HOLLOW CHISEL MORTISING AND BORING MACHINE.

The machine here illustrated, which is made by J. A. Fay & Co., of Cincinnati, O., is intended for mortising all kinds of heavy timbers used in car and bridge construction of all classes, either in hard or soft woods. It is a powerful and compact machine, is automatic in its operation, and works with great rapidity. When once set, and the machine started, it will make any number of mortises without change.

It is operated by the reciprocation of a square hollow chisel having an auger revolving in its centre, the chisel squaring the hole produced by the auger. The superiority of this method of mortising is apparent from the fact that the mortise is left in a completed condition, no cleaning out being required, and a mortise of any length can be made by continuously cutting one hole after another on the same line. The reciprocation of the chisel is automatic, and the work produced very rapidly by the ease with which the movements and adjustments can be made by the operator.

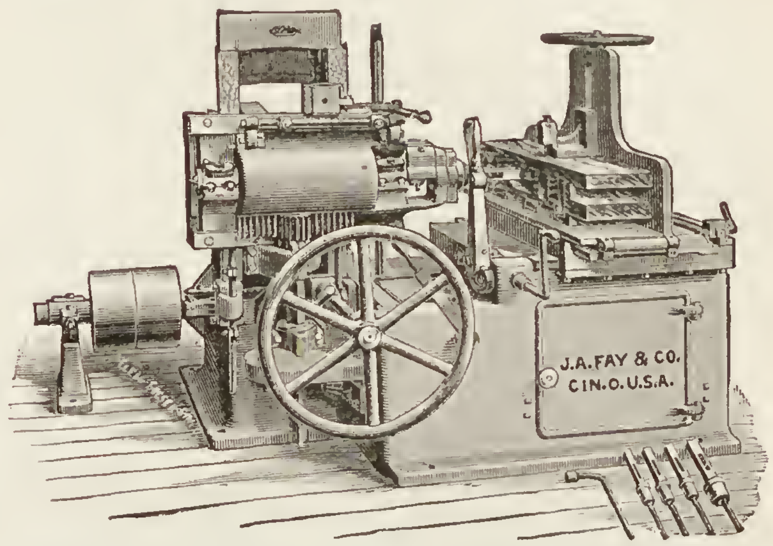
The bed supporting the timbers is massive, and capable of enduring the strain it is subjected to in heavy work. It has adjustments for carrying it to and from the chisel for different thicknesses of material and depths of mortises. It remains at one height, and is movable endwise to produce the varying lengths of mortises. There is a clamping arrangement for holding material in position, stops for gauging the lengths of mortises, and for using templates in producing duplicate mortises.

The chisel frame and auger spindle are carried on a heavy vertical column which is connected to the base on which the bed for the timber is placed. It has a vertical movement on the column to allow the position of the chisel to be varied up or down according to the desired position of the mortise. There are stops to regulate the height of the travel of the chisel frame, which is moved by means of the large hand-wheel, and has a device for locking firmly at the height of the mortise, and easily moved up and down for double mortising.

The reciprocating motion of the chisel frame is produced by a reversing friction and gearing which operates in a rack on the chisel frame, the driving force coming very near the point of resistance of the chisel. The reversing friction is operated by a trip on the chisel frame support, moved by dogs on the chisel frame, which are adjustable for varying distance of travel of the chisel.

The countershaft is attached to the machine, driving the reversing friction by two belts, and a belt to the auger spindle over a pair of idlers, one of which automatically adjusts to the varying lengths of the belt as the chisel is raised and lowered.

The machine can be used for single and double mortising for gaining, countersinking, end tenoning, and boxing. The chisel has a travel of 10 in. in depth, and the vertical range of work is 13 in. Mortises can be made to 2½ in. square. The table will receive material 15½ in. high. An auxiliary boring attachment can be added to the machine if desired. The machine is furnished with ¾-in., ⅞ in., 1-in., 1¼-in., and 1½-in. chisels and augers. A shop number is attached to each machine, reference to which in correspondence will identify the class of the machine and the style of its construction.

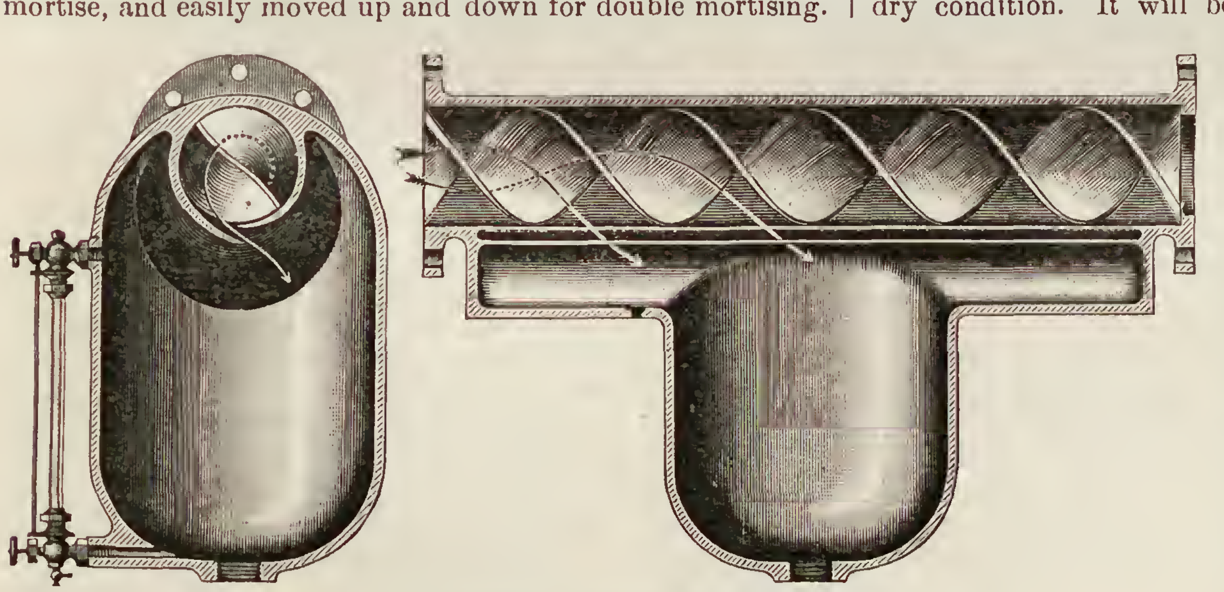


AUTOMATIC HOLLOW CHISEL MORTISING AND BORING MACHINE.

The tight and loose pulleys are 12 in. × 6 in., and should make 1,000 revolutions.

THE MOSHER STEAM SEPARATOR.

All experimenters with steam are well aware of the difficulty or, it may be said, of the almost impossibility of separating water from steam by gravity, whether it came there by entraining or condensation, as it has been found that a current of steam having a velocity of 3 ft. per second is amply sufficient to sustain and carry away a quantity of water. The separator that is herewith illustrated is one that has been designed by Mr. C. D. Mosher, of No. 1 Broadway, New York, in which he uses a centrifugal action to throw the water out of the steam, allowing the latter to pass on to the engine in a dry condition. It will be seen from the longitudinal and cross-sections that are given in the engravings, that the separator consists of a slightly enlarged section of the steam-pipe that is made of a spiral-shaped cross-section, and contains a worm running from end to end, this worm being so twisted that the course of the steam as it passes through it is given a whirling motion, and this whirl is such that it runs against the lip that is formed on the under side by the spiral. As the water is heavier than the steam, it is thrown out against the side of the separator and shaved off, as it were, by the lip, whence it may pass into the drum that is shown below, or into the boiler itself when the separator is placed in the dry pipe, while there is practically but little increase of resistance to the flow of the steam.



THE MOSHER STEAM SEPARATOR.

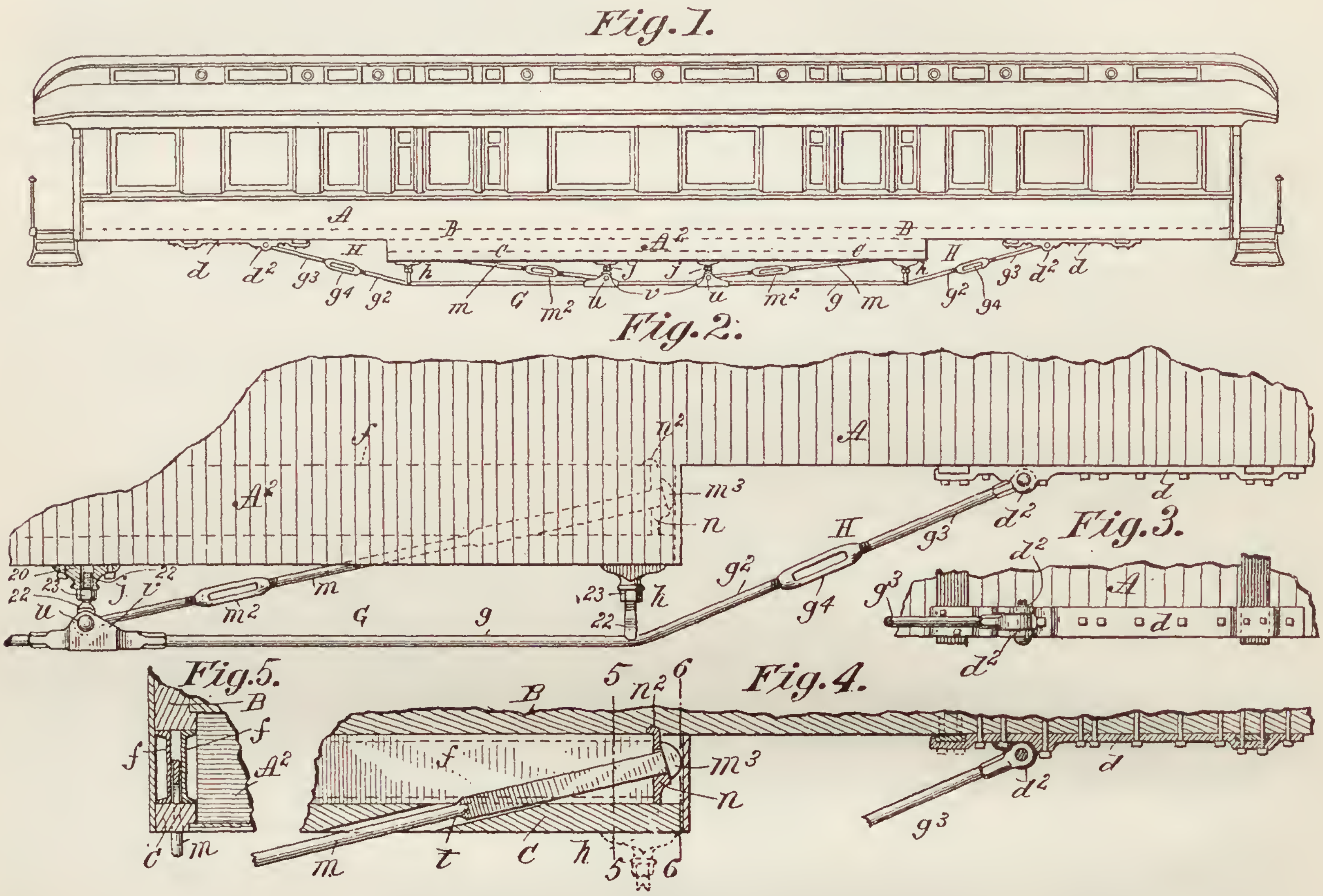
This style of separator is also particularly well adapted to the separation of oil from exhaust steam, and thus preventing the clogging of pipes when it is used for heating purposes and also the corrosion of metallic roofs upon which it would otherwise fall. It is built in sizes ranging in diameter from 1½ in. to 12 in., for the size of the steam-pipe, and is thus upon the market to meet all ordinary requirements.

Recent Patents.

RAILWAY CAR.

Mr. Henry Pearson, Superintendent of the Wason Car Company, near Springfield, Mass., has patented a method of framing passenger cars which seems to have much merit. The invention is primarily intended for what are known as "drop bottom" cars, or, in Southern vernacular, as "possum belly" cars, in which there is an extension of the car body or its sides below the floor of the car, in which berths, bedding or baggage may be disposed or stored, or which might be used for other purposes. It is not essential, either, that this space should be utilized for any purpose, as the sides might be extended downward merely to secure greater strength in the truss or frame of the car body.

In the illustration fig. 1 is a side view of a car having the form of construction proposed by Mr. Pearson. Fig. 2 is a side view of a portion of the car body in an enlarged scale. Fig. 3 is an inverted plane showing the parts of fig. 2 immediately above fig. 3. Fig. 4 is a vertical longitudinal section through the side sills at and along one side of the frame of the car body. Fig. 5 is a vertical cross section on the line 5 5 of fig. 4.



From fig. 1 it will be seen that the car body A has an extension or "possum belly," A^2, between its ends, and below the floor or bottom of the car. The car body has the usual side sills B B, shown by dotted lines in fig. 1. Below these are sub-sills C C, extending the whole length of the depressed portion A^2. Between the main sill B and the sub-sill C a pair of channel irons, f f—shown clearly in the sectional views, figs. 4 and 5—are placed. These form the top chord of the intermediate or secondary truss H v H, fig. 1, the purpose of which is to strengthen or support the central part of the car body. This truss consists of the rods m v m and queen-posts or struts j j. The method of attaching the rods to the channel bars is clearly shown in fig. 4.

The main truss d^2 G G d^2 is of the usual form, excepting that the rod T T has lugs u u forged on it, to which the rods m m are attached. This construction, and also that of the main queen-posts h h, are clearly shown in fig. 2. The main sill B B forms the top chord of the main truss, as in the ordinary method of construction; the downward extension, however, gives it more depth than such trusses usually have in passenger cars. This form of construction would therefore appear to increase the strength of a car very materially. The date of the patent is July 23, and the number is 543,050.

RAILWAY SIGNAL POST.

Figs. 6 and 7 represent an ingenious design for signal posts patented by Mr. Sherburn Sanborn, of Chicago, the construction of which he describes as follows in his patent:

"I take two bars of iron, B, provided with heads b and bases b', connected by webs b^2, and of the desired length to give the requisite height desired in the post. These bars are placed base to base and fastened together by bolts or rivets, as shown in the drawings, for a portion of their length. The bars above the point where their bases are riveted or fastened together are spread apart so as to afford a space, C (fig. 6) between the bases. This space affords room for mounting the operative parts of the signal in place between the bases of the bars, which are wide or broad enough to sufficiently house and protect them. The post, when thus completed, is intended to be securely set or planted in the ground to occupy a vertical position and elevate the signal-lights and other parts to the required height.

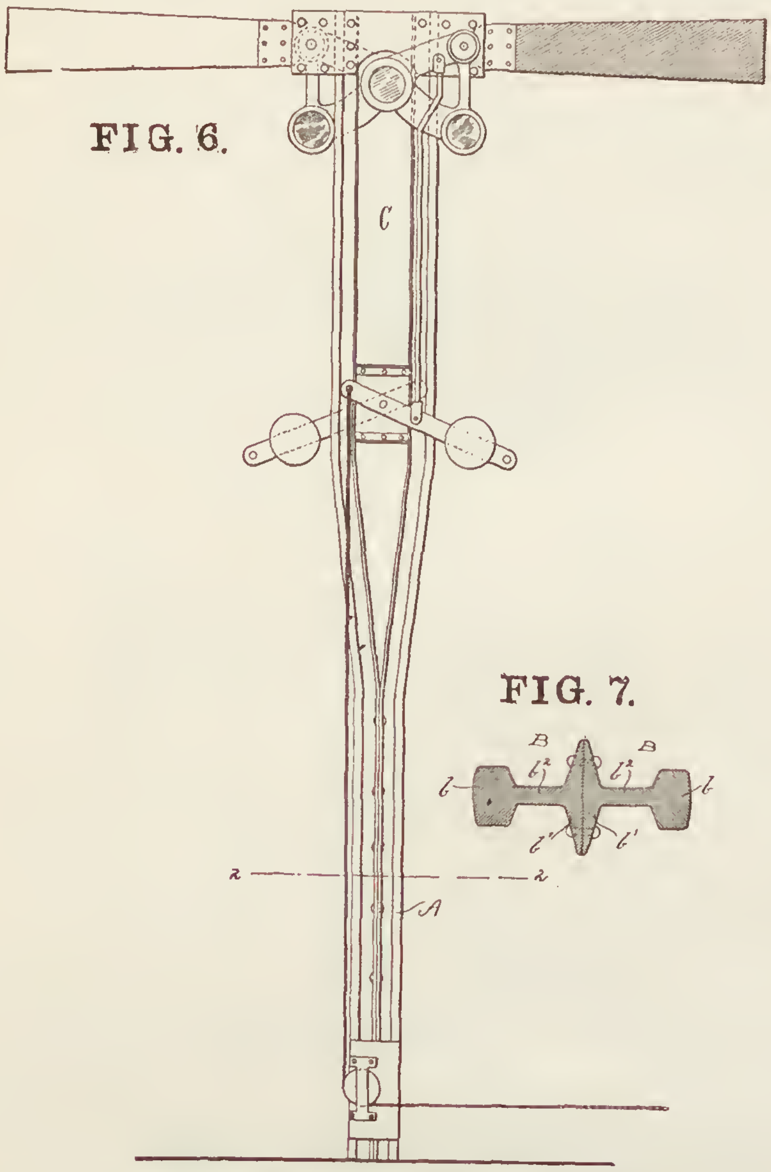
"By employing bars provided with heads and bases, as shown in fig. 7, which is a transverse section on the line 2 2 of fig. 6, sufficient base is secured to enable the post to be firmly and securely planted in the ground, while the diminished thickness of the web permits earth and gravel to be firmly and securely packed in, about, and around the post to prevent its ready or easy displacement, and the spreading of the upper portions of the bars apart furnishes less resistance to the action of the wind than where large and solid posts are employed, and at the same time sufficient room is secured for the location, arrangement, and operation of the working parts of the signal."

Obviously old and worn rails could be used for making these signal posts. The patent is dated August 6, and numbered 544,008.

STEAM BOILER.

Messrs. William Sellers, of Philadelphia, George S. Strong, of New York, and Henry B. Bradford, of Wilmington, Del., are the inventors of a steam boiler (figs. 8 and 9) which is described in their patent, No. 544,130, dated August 6, and which

they have assigned to the Edge Moor Iron Company. The objects of their invention are set forth as follows in their patent :



SANBORN'S RAILWAY SIGNAL POST.

"The improvements relate to that class of cylindrical steam boilers known as 'internally fired return tubular.'

"This form of boiler is usually provided with two furnaces and a manhole between and below them for access to the interior of the boiler shell and an uptake within the boiler near the rear end, into which the products of combustion from the furnaces are discharged, and from which they are carried through tubes above the furnaces to a smoke flue at the front of the boiler and above its fire doors to the chimney. With this construction the greatest heat of combustion is far below the surface of the water, so that the evolution of steam produces foaming when the work of the boiler is pushed to its maximum. Moreover, the smoke-flue being above the firing-doors compels the discharge of the products of combustion upward, whereby the light cinders and ashes must be carried forward with the current of heated gases without opportunity to separate otherwise than as a deposit in the flues or tubes, while ashes accumulate in the uptake, which cannot be removed while the boiler is in service.

"One object of our improvement, therefore, is to apply the greatest heat as near as possible to the surface of the water and at the same time to render the interior of the boiler accessible throughout its length, also to avail of the greater specific gravity of the cinders and ashes and to separate them from the gaseous products of combustion whenever the downward direction of the currents of gaseous products is changed.

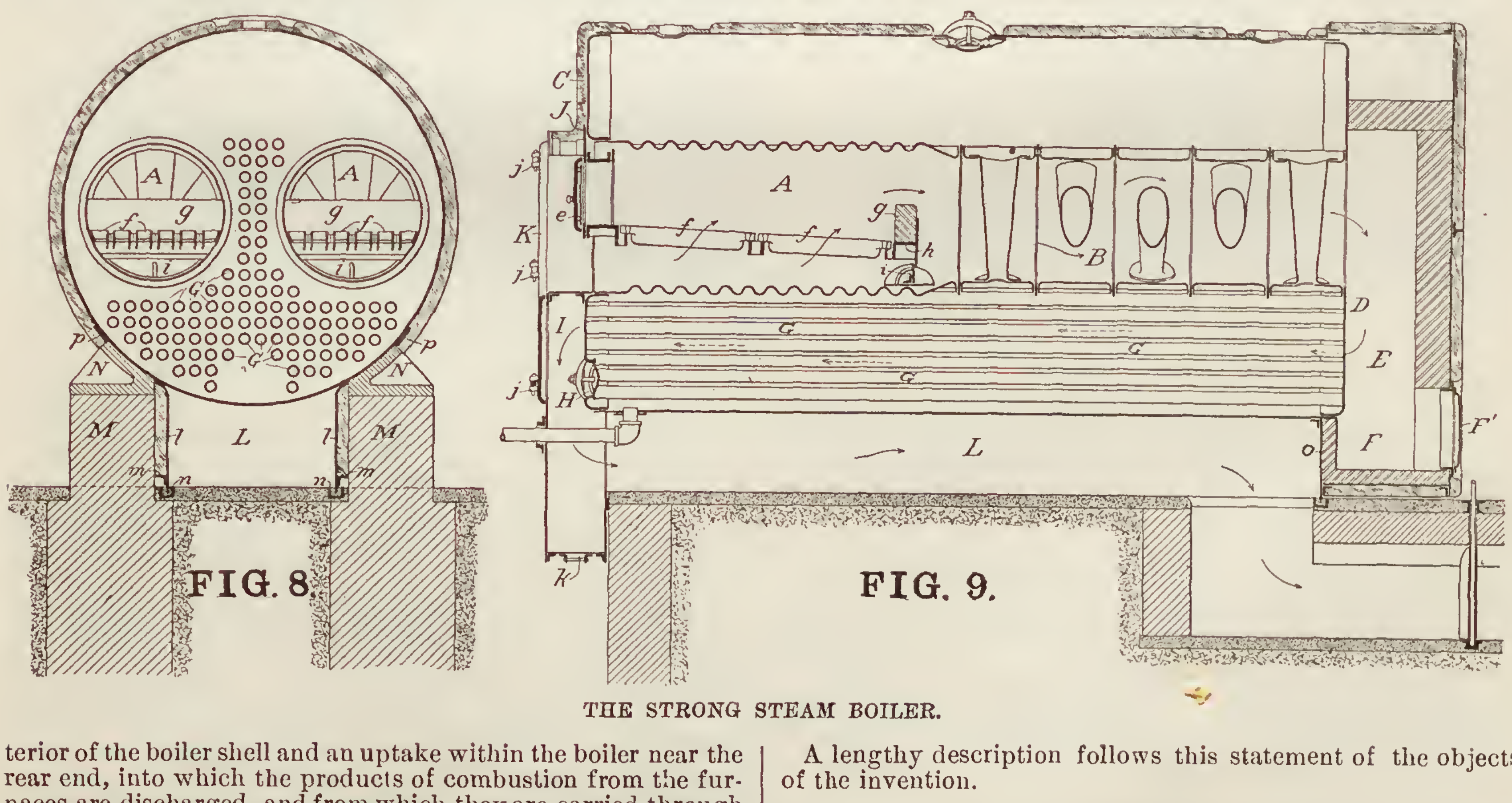
"Another is to carry off the products of combustion to the chimney along the under side of the boiler and at the same time provide for the expansion and contraction of the boiler without affecting its setting.

"Another is to provide a support for that end of the boiler which is movable upon its setting, which shall automatically adjust itself to produce a uniform pressure thereon.

"Another is to provide for removing the solid products of combustion from the tubes without removing from the boiler any part of the covering of its smoke-flues ; and another is to provide a descending smoke-flue on the front head of the boiler outside of and between and below the fire-door frames, which flue forms an extension of the ash-pits under the furnaces.

"The invention consists of two or more furnaces with combustion chambers, which respectively connect the front and back heads of the boiler and open through both, a smoke flue outside the back head, and return tubes secured in both heads between and below the tops of the furnaces and combustion chambers.

"It further consists in downward smoke-flues with cleansable receptacles below their outlets for the products of combustion ; in a series of horizontal tubes arranged in vertical lines and a hinge-jointed cover secured upon the front smoke-flue, the joint in this cover in a plane that will pass between the vertical lines of the tubes ; in a smoke-flue, the top of which is the boiler, from which the two sides and one end of the flue are suspended and penetrate a sand-joint on the bottom to a depth that will practically exclude the air ; and in two fixed supports at one end of a boiler and two roller supports at the other, the weight at the roller end transmitted to the roller supports respectively through a ball and socket, and it further consists in a descending smoke-flue on the front boiler-head, which flue is outside of and between and below the fire-door frames and forms an extension of the ash-pits under the furnaces."



THE STRONG STEAM BOILER.

A lengthy description follows this statement of the objects of the invention.

CAR TRUCK.

Mr. Albert K. Mansfield, of Salem, O., is the inventor of the truck shown by figs. 10, 11 and 12, and described in patent No.

545,409, dated August 27, of which he has assigned one-half to Samuel M. Felton, of Cincinnati.

One of the principal objects aimed at in this design is to use ordinary shapes of I beams, channel bars and plates in its construction, which are a common article of merchandise in the open market, and which can therefore be obtained at lower cost than special forms could be.

The side frames 1 of the truck shown consist of I beams with openings or "jaws" cut into their lower sides to receive the boxes 2 2. These openings are then reinforced by angle bars 3 bent into the form of an inverted letter ∩, and which are riveted to the web of the I beam as shown. The lower portion of the jaws are then held together by pedestal braces 4 bolted to the lower flanges of the I beam 1. Fig. 11 is a transverse section through the transoms and fig. 12 is a horizontal section on the line x x.

The transoms consist of channel bars 10 10, which are fastened to the side frames by angles 11 11, to which they are riveted. These channel bars are braced on their under side by diagonal braces 12 12, which hold them in position and keep the truck square. The bolsters consist of a pair of I beams, a sectional view of which is shown in fig. 11. The springs are supported by plates 15, which are bent into U shape and are riveted to the channel bars. The design seems to be an excellent one, and as only ordinary standard shapes are used in its construction, and as little or no special machinery would be required for the manufacture, this truck should have the advantage of cheapness; and if the cost is lessened and the endurance lengthened there it will have the happy collocation of merits which all are striving to obtain.

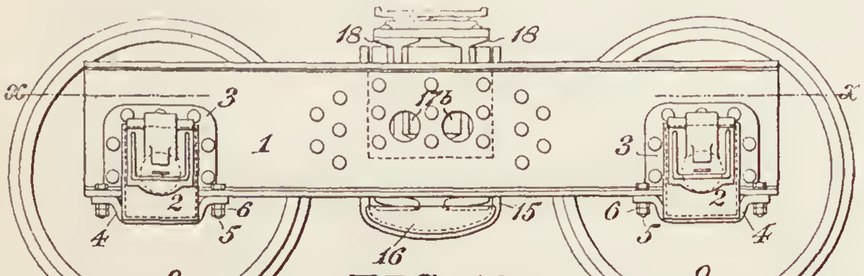


FIG. 10.

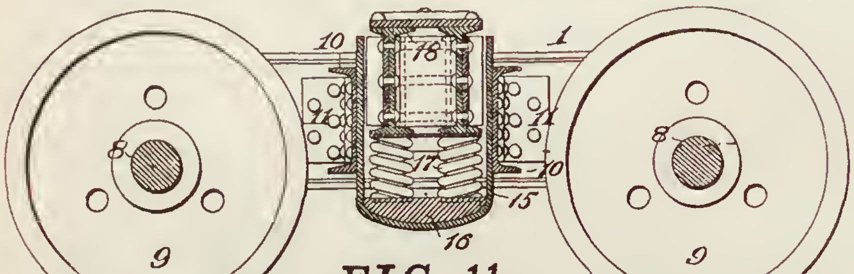


FIG. 11.

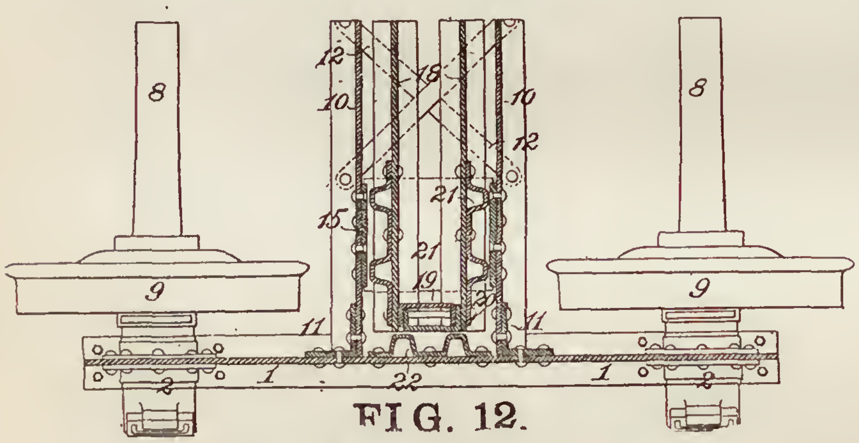


FIG. 12.

THE MANSFIELD CAR TRUCK.

ILLUMINATED SEMAPHORE SIGNAL.

Mr. Jacob W. Lattig, of West Bethlehem, Pa., has patented a form of illuminated semaphore arm, shown in figs. 13 and 14, which he describes as follows:

"Extending along the longitudinal centre of the semaphore arm is a row of incandescent electric lamps, h. These lamps are secured by their sockets to the semaphore arm, and are placed preferably at intervals apart of a foot throughout the length of the blade.

"The lamp terminals on one side are connected to a wire, 1, common to all. On the other side each lamp terminal has its individual wire leading and connected to a stationary brush pertaining to that lamp terminal alone, there being as many brushes (numbered 2 to 7, inclusive) as there are lamps. These brushes are arranged as the stationary contacts of a commutator around a rapidly rotating contact or trailer, 8, which meets the brushes successively, preferably making contact with the one in advance just before it quits the one next in rear, to prevent arcing at contacts. The rotating contact is intended to revolve continuously when in action, being driven for this purpose by any suitable motor, electrical or otherwise. Where direct currents are employed, I prefer an electrical motor to run the commutator. Where alternating currents are employed, I prefer a mechanically operated commutator, the mechanical motor in the present instance being clock-work typified by the cord and weight X. The wire 1, by a flexible cable, x, is connected to the wire 9 on the post leading to one pole of the source of electrical supply, the other pole of which is connected to the revolving commutator contact disk 8 by wire 10. There is a similar flexible connection, x' x^2, etc., between the individual lamp terminal wires and their respective stationary contact springs or brushes 2, 3, etc. The flexible connections x x' x^2, etc., are for the purpose of permitting the free movement of the semaphore arm on its pivot. A switch, Y, is provided to make and break the circuit, as desired. When the circuit is closed at Y and the commutator in action, the lamps will successively be brought into circuit, one during each revolution of the commutator disk. The effect upon the eye of the observer, owing to the rapid rate of the movement of the trailer 8, will be a streak of light running from end to end of the semaphore blade intermittently, no matter what may be the position of the arm, whether inclined or straight. The light may be white, red, green, or any other color desired.

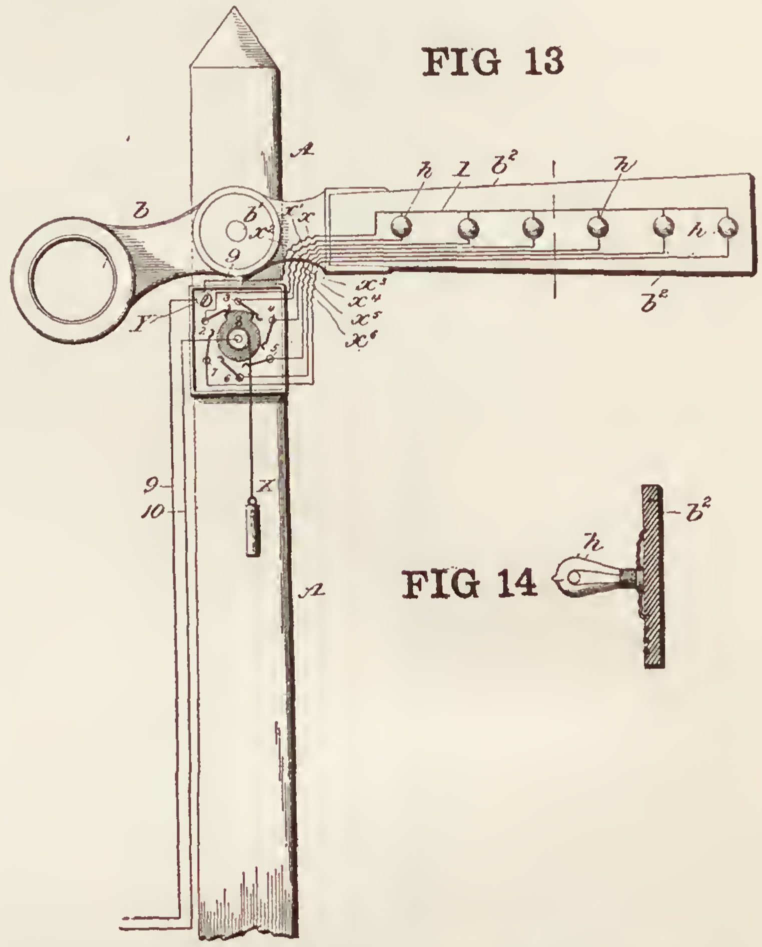


FIG 13

FIG 14

THE LATTIG ILLUMINATED SEMAPHORE SIGNAL.

"The arrangement, while producing the impression of a continuously moving streak of light, economizes current materially, as the quantity of current consumed will not exceed materially, if at all, that required to maintain a single constant light. A light may be placed behind the spectacle glass in the casting b, if desired, and this light may be made to take its turn along with the rest by providing suitable commutator connections for it.

"Under my improvements the same line of lights are exposed to the train at all times, and those lights are not continuous, but intermittent. Not only is there economy in this last feature, but also a new effect is produced in railway signalling. The rapid running intermittent streak of light produced by the rapid movement of the trailer contact makes a very much more distinctive signal and will more readily attract the attention of the engineer. The signal becomes in effect an automatic flagman, to stop or start a train by movements similar to those employed by the flagman with his lantern or flag for the same purpose."

The patent is dated September 3, and numbered 545,071.

AERONAUTICS.

NOTICE.

In our issue of last October it was announced that thereafter Aeronautics would be made "a supplementary subject in The American Engineer," and "that under that heading it was intended to give the most reliable information relating to the science and art of aerostation." Since that time a separate department, occupying from four to six pages, has been devoted to that subject. Owing to insufficient patronage, this department will be discontinued after this issue of The American Engineer. Hereafter important events, which indicate that real progress has been made in the art or science of aeronautics, will be chronicled, but it will be published with other matter, and not in a separate department.

AEROPLANE STABILITY DURING FLIGHT.

By William Kress, Vienna.

The simplest form of aeroplane construction, used by myself since 1879, consisted of a main concave carrying surface at the front and of a large flat surface, or tail, at the rear, forming thus two horizontal carrying surfaces, as far apart as practicable, between which were located two elastic sail air screws or propellers, either side by side, or one behind the other, and rotating in opposite directions. Under the tail or horizontal rudder, and as far to the rear as possible, was located a vertical rudder. A fish-bellied car was suspended below, and mounted on sled-runners in such a way that the apparatus, when on the ground, should present a small upward angle of incidence to the air, the main aeroplane being, however, attached horizontally, or parallel to the axis of the air-screws; the inclination of the machine, upward or downward, during flight being produced by changing the position of the horizontal rudder, or being due to a change in the velocity of the whole apparatus.

Hence, the position of the main front surface, and also the centre of gravity of the machine, are left unchanged as much as possible, and are not moved about by any mechanical contrivance. It is a mistake, into which many aviators have fallen, to suppose that an aeroplane can only be kept in equilibrium during flight by a mechanical adjustment of its centre of gravity or of the centre of pressure of its wing surface, or by changing the angle of incidence of its wing surfaces. Marine navigation would be quite impossible if a ship could not maintain its equilibrium automatically on the waves, but was dependent for its safety upon the skilful manipulations of some mechanism by the steersman.

In order, however, to give the aeroplane as great a stability as possible, and to make it as little sensitive as may be against any accidental changes in the centre of gravity, I now separate my horizontal carrying surface into two or more surfaces of about equal size.

It is true that a single carrying surface, with the addition of a small horizontal rudder, attached immediately behind the main wing (so that the centre of oscillation coincides very nearly with the centre of pressure), has been used by an aviator of high standing, in an apparatus widely advertised of late throughout the world; but this apparatus, at least in its present shape, requires the skill of an acrobat for its manipulation, and exposes the aviator to such risks that it cannot be accepted as a solution of the problem.

I consider it as a prime requisite in any flying apparatus that it shall have at least two distinct points of support, and that the centre of gravity shall be between the two, in a position as fixed and immovable as possible.

In the course of my experiments I have often placed a small weight in the car of my model, sometimes in the front and then again in the rear, without destroying the equilibrium or producing a marked oscillation of the apparatus in flight. This proves sufficiently that passengers will be able to move about in the car of a properly designed aeroplane machine, and to change places pretty freely without materially disturbing the balance of the apparatus.

I have lately built and tested in flight a model (fig. 1) with three horizontal surfaces, B^2, B^1, and C of the illustration herewith.

The addition consists in the head wing B^2, and although this second model maintains its equilibrium very well, I have become convinced that the head wing B^2 was placed too close to the main wing B^1, and that the horizontal rudder C was too small. The use of three carrying surfaces presents the disadvantage that the main point of support is too close to the centre of gravity. It is clear, however, that the larger the number of aeroplane surfaces in an apparatus, at proper distances, the greater will be its stability, and I have designed a further improvement in which I have used four carrying surfaces.

In the case of several wing surfaces, thus arranged one behind the other, they must be separated by at least the width of a wing, and each wing must be slightly lower than the wing in front of it. They must all be attached parallel to the propeller axis—that is, at an angle of 0°, as shown in fig. 2.

The centre of gravity of the whole apparatus must always be well toward the front, and when the machine is not in motion, the centre of gravity must never coincide with the centre of pressure on the wing surface. As the centre of pressure is variable, and tends to move forward when the velocity of the apparatus increases, the position of the centre of gravity must be arranged, in designing the apparatus, for

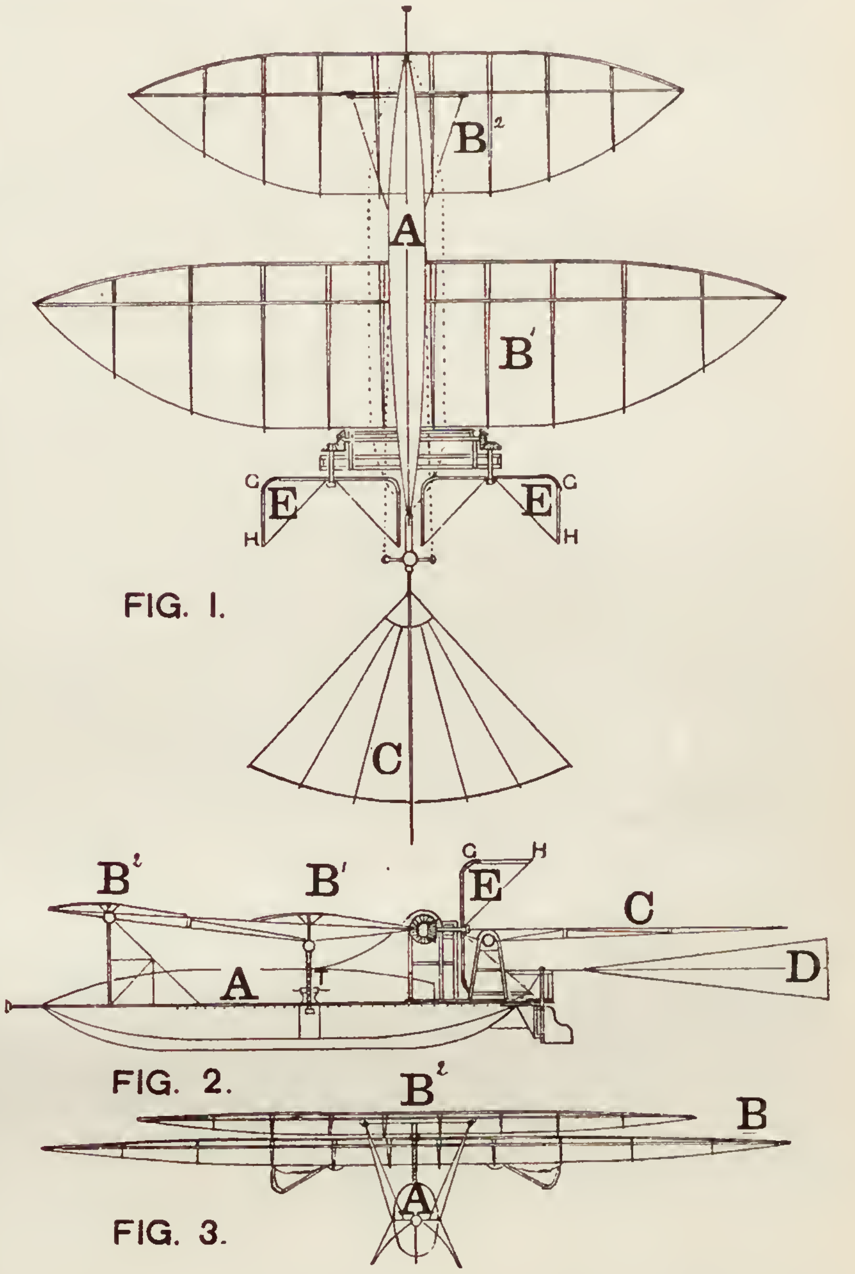


FIG. 1.

FIG. 2.

FIG. 3.

an average speed of motion. As the centre of gravity under variations of speed will never have quite the same relative position to the centre of pressure, there will be produced oscillations of the apparatus, but these oscillations will be gentle and harmless, and can easily be checked by the horizontal rudder C.

In any case it is not advisable, during flight, to change the position of the centre of gravity or the inclination of the main wing surfaces. Any desired upward or downward direction can be obtained in the best and safest manner by means of the horizontal rudder.

Before attacking the more important question—viz., *How does the aeroplane maintain its equilibrium in changing velocities of the wind—i.e., during wind gusts?* let us first consider the flight of the machine in calm air, or in a steady current of wind.

In a perfect calm rising up from the ground is most difficult, and in such a case the aeroplane must be put under way in a suitable open field or on the water, until it acquires a horizontal velocity of some 8 or 10 metres per second, or 18 to

22 miles per hour. Only after it has acquired this speed can it be steered upward by means of the rudder *c*, so as to rise upon the air as upon an inclined plane.

Let us now assume that the aeroplane has acquired, through its motor, a proper elevation and a velocity of 15 metres per second (33 miles an hour), and that the horizontal rudder is so adjusted that, at this velocity, the apparatus maintains an exactly horizontal course.

If we now change the inclination of the horizontal rudder *C* a trifle, the aeroplane will at once leave its horizontal path and move upon a new course, inclined to the horizontal, either upward or downward, according to the set of the rudder. If the motion be upward, the speed will, of course, be retarded. If the course be downward, there will be an acceleration of velocity. The same result would ensue, without change in the position of the rudder, by a variation in the speed of the aeroplane, or again by a simple displacement of the centre of gravity toward the front or toward the rear.

In all the three cases the aeroplane would no longer move in a rectilinear path, but pursue an undulatory course, alternately rising and falling. For suppose, for instance, that the aeroplane is moving with a normal velocity of 15 metres per second (33 miles an hour) in a straight horizontal path, and suppose that by forcing the motor the velocity is increased to 20 metres per second (44 miles an hour), without in any way changing the position of the rudder *C*, what will then happen?

The greater velocity not only produces an increase in the supporting power of the carrying surfaces and thus causes the machine to rise, but it also causes the centre of air pressure on the wing surfaces to move toward the front, and thus tilts the aeroplane in an upward direction. The increased "head wind" will then meet with a greater inclination of the wing surfaces, and will tend to cause the apparatus to "rear up."

Fortunately two important factors then come into action, which will automatically counteract this dangerous tendency. From the very instant at which the apparatus begins to assume an inclined position, the centre of gravity, which is below the supporting surface, will move forward by oscillation; at the same time the increased "head wind" and the greater vertical projection of the machine will *retard* the speed of the forward motion, thus causing the centre of air pressure to move backward again. This combined forward movement of the centre of gravity, and backward movement of the centre of pressure, will, of course, force the aeroplane to return to its original horizontal position. As soon as it has resumed its horizontal course, if the motor continues working at its increased speed, the velocity of the machine will again be accelerated, and the series of movements above described will be repeated.

We may therefore conclude that if a velocity greater than that corresponding to the position of its rudder *c* is imparted to the aeroplane, it will move in an undulatory line, gradually rising upward.

If, on the other hand, the reverse takes place, and the speed falls off from 15 metres to, say, 10 metres per second, precisely the same sequence of motions will take place, but in the reverse order. The centre of pressure will move backward, the apparatus will tilt downward to the front, thus causing the centre of gravity to move toward the rear, the velocity will be accelerated, and the increased pressure will then tilt the aeroplane back into a horizontal position, thus bringing about a series of oscillatory movements, and a wavy course inclined downwards.

It will depend upon the construction of the aeroplane, whether these waves are short and steep, or long and gradual. If the carrying surface is concentrated and is close to the centre of gravity, the waves and oscillations will be steep and dangerous; but if we use several distinct carrying surfaces, the wave action will be gradual and hardly perceptible.

That an aeroplane, moving in calm air, actually behaves in the manner above described, is proven by my experiments with models constructed by myself, which have been frequently exhibited in public during many years.

As my models are necessarily left to themselves during flight, the rudder *c* must be set at a definite angle for each trial, so that it is practicable to observe exactly in each experiment, from the amount of wavy motion, how closely the velocity and the set of the rudder may agree.

During Professor Boltzmann's lecture at the Naturalists' Convention in Vienna, in September, 1894, I succeeded in making my model fly, in an almost entirely level path, over the heads of the learned audience, into a proscenium box opposite.

If we now pass to the consideration of flight in a current of air, moving with uniform velocity, it will prove that the starting, the alighting, and the rate of motion relative to the earth, will be quite different from what the same operations are in a calm; but when the aeroplane has left the ground, and is immersed in the air, so that it has no physical connection with the earth, then its stability will be exactly the same as in calm air. It will be under the influence of no wind pressure, save that of the "head wind" produced by its own forward motion.

If we assume that the uniform wind current has a velocity of 10 metres per second (22 miles an hour), the starting of the aeroplane from the ground will be very easily accomplished. It will not need any preliminary run. It will suffice to dispose the apparatus with its head to the wind, to start the air-screws *E*, and to set the horizontal rudder *c* at the proper angle, in order to rise directly upward. If the aeroplane have a velocity of its own of 10 metres per second, against a wind of the same velocity, it will not possess *any* horizontal motion relatively to the earth, but will rise vertically upward. If the aeroplane be then propelled by its motor at its normal velocity of 15 metres per second, *against* a wind blowing 10 metres per second, it would move at a speed of 5 metres per second relatively to the earth. If moving *with* the wind, its speed relative to the soil would be $10 + 15 = 25$ metres per second. If, again, the air-ship have a lateral motion, say at right angles to the direction of the wind, the resulting movement would be deduced by the parallelogram of forces.

In all these cases the "head wind" acting against the aeroplane will always be simply one of 15 metres per second.

If, therefore, the aeroplane moves in a wind current blowing uniformly, it will be under exactly the same conditions as if it were sailing in calm air. The stream of air acts as that which we think of as "wind," only in relation to the earth or to a body anchored to the earth, but not so for a body immersed in the air, resting on and carried by it. A stream of air of this kind has no influence on a flying body, except in so far as it influences its movement relatively to the earth.

It must be remarked, however, that we do not meet with uniform currents of air close to the earth, and that in every case the velocity of the wind, and in many cases the direction also, changes at every instant. This may be tested in strong winds both by touch and sound, and Professor Langley has further demonstrated the fact with his measuring apparatus. Our air-ships must therefore deal with varying air gusts and waves, which render the situation a different one as regards the functions of a flying machine and its construction.

These variations in the velocity of the wind have, or rather may have, a very great influence on flying machines.

If properly utilized, they actually offer a source of power which enables soaring birds to fly through space without wing beat, and almost without any expenditure of work.

The variations in the velocity of the wind, on the other hand, may prove to be the source of great dangers to our future air-ships, as they may make more difficult the maintenance of the equilibrium, which is one of the most important requirements in aerial navigation.

I will now endeavor to prove that my aeroplane will automatically maintain its equilibrium, without any moving mechanical contrivance, notwithstanding the influence of wind gusts.

Let us again assume a normal speed of 15 metres per second for the aeroplane, and let us assign an average velocity of 10 metres per second to the wind, which, however, constantly is to vary between 15 and 5 metres per second; rising to 15 metres and instantly dropping to 5 metres per second, and so on.

If we now suppose the machine to move against the wind, just when the latter is beginning to increase its velocity, the increasing "head wind" will place the aeroplane under exactly the same conditions as those above described for a calm, or when the speed of the ship itself was increased without changing the velocity of the wind. In both cases the "head wind" will increase. In the former case there was an increase in the head resistance in consequence of the greater speed of the air-ship; in the present case this results from the greater speed of the wind. The centre of pressure will again, as in the former example, move forward, and the machine will be tilted upward and move in an upward direction. At the same time the forces tending to counteract this motion come into play; the centre of gravity moves toward the front as a result of the upward motion and increased head resistance, a retardation of the velocity and a retrogression of the centre of pressure takes place, etc.; in short, the apparatus will be forced back into its original position, exactly as is the case for motion in a calm. The path will again be a wavy line upward.

There is this difference, however, that while in a calm the motor was obliged to do an extra amount of work in order to raise the machine higher, in this last case the air-ship is lifted up without any extra work being done by the motor. The

result comes from an external cause, from the difference in wind velocity, or from the "internal work of the wind," as Professor Langley calls it.

It is true, however, that the machine, when it has been lifted up, has lost 5 metres per second of its velocity with reference to the earth, but not with reference to the surrounding air; for the amount of velocity lost by the apparatus by the upward flight is exactly made up by the accelerating effect of the wind, so that the machine reaches the higher level with its original velocity of 15 metres per second as regards the air surrounding it. Seen from the earth, however, the air-ship would appear to be stationary.

Let the wind then slacken and drop down to a speed of 10 metres, or even to 5 metres per second. The effect of this decrease in the "head wind" will be exactly the same as if, in a calm, the motor were to move more slowly, and we should then have the same succession of phenomena as were described in the case of varied motion in a calm. The apparatus would drop, and move downward with an accelerated motion; the well-known counteracting forces would come into play and bring the machine back to its normal position, so that its course would be downward in an inclined undulating path.

When the air-ship has come back to its original level and the wind to its original velocity of 10 metres per second, then the apparatus will have, with reference to the earth, a velocity of $v_1 + f - v$, if we term v_1 its own speed, f the acceleration due to the downward movement, and v the speed of the wind; then if $f = 5$ metres, the aeroplane at this instant has a velocity of $15 + 5 - 10 = 10$ metres per second with reference to the earth. Of course this acceleration is lost as soon as the apparatus has resumed its original horizontal position.

Let us now consider the other case, and investigate what will happen if the air-ship is flying in the same direction as the wind. Let us assume again that the aeroplane is moving with its own normal velocity of 15 metres per second and in the same direction as a wind of 15 metres. The combined velocity with reference to the earth will be $15 + 15 = 30$ metres per second in the wind's direction.

Suppose, further, that the wind suddenly drops to a speed of 10 metres per second, then the effect on the machine will be the same as that above described with a wind increased in velocity, or the same as when, *in a calm*, the motor was urged so that the speed of the machine increased. In this case the "head wind" will increase, the machine will take an upward course, and its speed will then be retarded. The sequence of motions will be the same as already described, and the air-ship will move upward on a series of undulations without any increased expenditure of motive power. The difference in wind velocity is again the source of energy, but in this case it is the *diminution* of the wind's speed which acts as a source of power. When the apparatus reaches the higher level, it has a velocity relatively to the earth of $v_1 + (v - w)$, in which w is the retardation due to the upward movement If $w = 5$ metres per second, then the velocity of the machine at this instant is $15 + (10 - 5) = 20$ metres, so that the greater elevation has only been attained by using up the velocity of the apparatus.

As soon as the aeroplane, after rising, has resumed its horizontal position, the retardation ceases, and the apparatus resumes its normal velocity of 15 metres per second, without losing the elevation acquired; moving with reference to the earth with a velocity of $15 + 10 = 25$ metres per second.

Let the wind again begin to increase in velocity, rising from 10 metres to 15 metres per second, and its influence on the apparatus will be exactly the same as though the speed of the motor was decreased in a calm. The "head wind" will be less, and the machine will move downward on an inclined wavy path.

When the air-ship has come back to its lower level, and the wind's velocity has risen to 15 metres, the former will have a velocity, relatively to the earth, of $(v_1 + f) + v = (15 + 5) + 5 = 35$ metres per second, if f be termed the acceleration and equal to 5 metres per second.

We see clearly, in this case, that the apparatus has gained 5 metres per second in velocity, without any expenditure of power on the part of the motor.

While in the explanations just given I merely intended to prove that wind gusts can only affect the stability of an aeroplane machine by causing it to perform certain undulatory motions, which, when the apparatus is properly designed, will be quite flat and gentle, and will not endanger it so long as it does not touch the earth, yet I could not help touching briefly upon the natural source of energy which is at the disposal of the soaring bird, in the constantly varying velocities of the wind.

It now remains for me to consider the *lateral* wind gusts and their influence on the stability of the aeroplane.

Let us assume a uniform current of wind blowing from a to b, with a velocity of 10 metres per second, while the aeroplane is steered with a velocity of 15 metres per second in the direction $a\ a'$—that is, at an angle of 90° to the direction of the wind. In this case the air-ship, as seen from the earth, will move from a to b^1 with a velocity of $\frac{v_1}{cos.\ \alpha}$. If, however, it is desired to have the machine reach the point a', then it must be steered in the direction $a\ d'$. It will then, as seen from the earth, move from a to a' with a velocity of $v_1\ cos.\ \alpha$.

In case the velocity is 15 metres per second, the aeroplane will have to be steered toward e'. It would then again travel, relatively to the earth, from a to a', but with a speed of $v_1\ cos.\ (\alpha + \beta)$.

In all these cases the aeroplane does not feel any lateral wind, it is flying in a calm, with merely a "head wind" of 15 metres per second, due to its own velocity.

Suppose, however, that the lateral wind current is not uniform, but has a velocity varying at every instant. Take, for instance, its mean velocity at 10 metres per second, rising at one instant of time to 15 metres and again dropping to 5 metres, and so on. In such a case the air-ship feels only a part of this change of velocity in the lateral current, and only for a very short space of time, until the apparatus has assumed its new direction.

In case the wind, while the air-ship is steered from a to d', suddenly rises from 10 metres to 15 metres per second, the machine will be struck by a "side wind" of 5 metres per second, coming from the right hand side. This current from the right will strike the vertical rudder D (fig. 2), which is attached on a long lever, far to the rear from the centre of gravity, and this will automatically direct the air-ship in the direction $a\ e'$. In case now the velocity of the wind suddenly drops to 10 metres per second, the aeroplane will again be struck by a side wind of 5 metres per second, but this time from the left-hand side, and the vertical rudder D will at once bring it back to the course $a\ d'$.

In such cases the air-ship would, of course, be subject to strong side gusts. It seems, however, quite out of the question that the wind shall ever increase suddenly from 10 metres to 15 metres per second. It will rise slowly and die away slowly, so that the vertical rudder D will begin to act at the very instant that the wind velocity changes, and will give the machine the proper direction. The aeroplane will therefore *never* be exposed to the full difference of velocity, but will only be subjected to gradual changes, which will merely force it to pursue a gently undulating line, such as $a\ d^2$.

The aviator will use the horizontal rudder c and the vertical rudder D in order to give his air-ship the desired direction and elevation during flight, as well as when starting and landing, but the maintenance of equilibrium must take place automatically without any special mechanism, and must not be dependent solely upon the skill of the aeronaut.

In order to make a landing, when flying in windy weather, the machine must be steered dead against the wind before touching the ground. It should be given a velocity, as nearly as may be possible, equal to the speed of the wind, so that it will be at rest relatively to the earth, and will drop gently downward, until it rests on the ground.

When making a landing in a dead calm, it is necessary to steer so as to give the machine a quick and strong upward glance, so as to check the velocity as much as possible, before dropping to the ground after bringing the apparatus back upon a level keel.

When resting on the earth the aeroplane is liable to be upset by every wind gust, unless it be so mounted as to turn automatically upon a pivot, like a weather vane, and thus adjust itself directly in the line of the wind. When it has risen into the air, and is immersed in this elastic medium, and has acquired a definite velocity of its own, then the wind gusts can no longer harm it. They can only force it to follow long and gentle undulatory paths, either horizontal, vertical, or a combination of the two.

For a body immersed in air, the difference between a calm and a current is, so far as the maintenance of equilibrium is concerned, by no means so great as is commonly but erroneously assumed. A ship in the stormy sea, dipping its keel into the inelastic water, while its great sails are buffeted by the wind waves, is much harder to keep in a state of equilibrium than an aeroplane entirely surrounded by an elastic medium.

I regret that, hitherto, it has been impossible for me, from pecuniary reasons, to construct a full-sized aeroplane machine, in order to prove practically that it can be kept in a condition of stable equilibrium, as easily as I have demonstrated can be done by my small-scale models.

A SIMPLE AEROPLANE.

To the Editor of AERONAUTICS :

Mr. Albert A. Merrill, of Boston, recently made some interesting experiments not far from the Blue Hill Observatory, near Boston, on August 24. The experiments were conducted in a field belonging to Mr. Hemenway, which is about a mile from the observatory. The apparatus was a two-winged aeroplane, having a total spread from wing tip to wing tip of 22 ft., and a width of 7 ft. The wings consisted of two rectangular bamboo frames of canvas connected by a continuous pole. Thus the wings were not hinged at the point in the centre where there was an opening for the body of the experimenter. The guiding movement was made by slanting upward the whole apparatus at an angle, so that when one wing extended upward the other extended downward, thus resulting in a circular flight. Mr. Merrill told me that his apparatus weighed only 21 lbs., but he said Herring's aeroplane weighed only 19 lbs. Mr. Merrill's apparatus cost only $15, and his system of using canvas covers for the frames seems admirable. By running with the outspread wings against the wind, Mr. Merrill was supported clear of the ground for a distance of 15 ft. down the incline of a steep hill. Mr. H. F. Clayton, of Blue Hill Observatory, made two flights or jumps of about the same length ; and in one instance, the aeroplanes, owing to a puff of wind, raised Mr. Clayton 4 ft. or 5 ft. above the ground, when the long rod connecting the wings broke, and Mr. Clayton dropped to the ground with the disjointed aeroplanes on top of him ; but he happily was not injured. It was the opinion of all that, had the wings not broken, Mr. Clayton might have been lifted a considerable distance by the opposing wind, which was somewhat gusty. The experiment clearly demonstrated the supporting power of the air. Among others present at the experiment besides the writer were A. Lawrence Rotch, Director of the Blue Hill Observatory, Charles S. Rackemann, and J. T. Burr, Jr., of Milton, Mass.

BAYONNE, N. J. WILLIAM A. EDDY.

NOTES.

Clearing Snow from Balloons.—In a lecture before the annual Congress of French Scientific Societies, delivered on April 18, 1895, by Mr. C. Jobert, the veteran mechanical engineer and aeronaut, he discussed the difficulties likely to be encountered by snow falling upon a balloon in Arctic explorations, and proposed a device to remedy them.

This consisted of a curved rib or semicircle of wood, pivoted at its centre upon the upper pole of the balloon, and supported at its lower ends by beams extending to a turntable placed around the gathering circle of suspension. This rotating rib is to be armed with brushes, coming into contact with the upper hemisphere of the balloon, and sweeping off the snow as it falls. The upper hemisphere is, moreover, to be protected against hail by an outer skin underlaid with cotton batting, resting upon the main skin, so as to prevent the balloon from being pierced or rent by hailstones.

The car is to be of metal, boat shaped, and to contain a motor which may either rotate the curved rib or actuate propelling screws to rise or descend, or even to drive the boat forward should it fall into the water. A supply of compressed hydrogen, to fill pilot balloons and to repair losses, is to be carried in a cylinder placed under the seats, and a water drag is provided in the shape of a bucket, which may be controlled from the car, so as to fill or empty at pleasure.

It is suggested that the balloon skin may be made impermeable by galvanic deposition of copper, nickel or aluminum upon a properly prepared cloth, or by interposition of metallic foil between two layers of the tissue. A sort of lightning-rod would then be placed on the top of the balloon, with a conducting wire to disperse possible discharges of electricity below the car.

The scheme is ingenious, and, although somewhat complicated, might be worth testing experimentally in a snowstorm.

Swedish-Norwegian Union Flag to Fly at the North Pole.—Mr. E. Sallström, living in the Argentine Republic, in sending a draft for a sum of money* to Mr. Andrée, the aeronaut who proposes to go to the North Pole in a balloon, says : "No matter how nicely the economical part of your gallant scheme may be cared for, there will always be some article of more or less importance which you will have to spare and which might be purchased for the money inclosed—for instance, a union flag, if nothing else."

* The draft was for about $1,000.

We learn that all the money required for Mr. Andrée's expedition has been obtained, and that in all probability he will make the attempt next June.

Long-Distance Signaling at Sea.—During the recent British naval manœuvres tests were made of two new systems of transmitting long-distance signals by night and day between ships at sea. The instruments used in connection with the experiments are the separate inventions of two naval officers, and in both cases it is understood the results obtained were highly satisfactory, showing a decided advance in a matter of paramount importance in carrying out steam tactics and other evolutions incidental to modern warfare afloat. It is also stated that the mast-head semaphore devised by Rear Admiral A. K. Wilson, V.C., has proved exceedingly useful for rapid and trustworthy communication with vessels within a radius of 10 miles, beyond which distance the movements of the arms could not be clearly made out. The collapsible drum, invented by Rear Admiral C. G. Fane, Admiral Superintendent of Portsmouth Dockyard, could not be manipulated quite so quickly as the semaphore, but will probably find more favor in the eyes of experts, inasmuch as signals made with it on board the *Blenheim* were accurately and easily read on board the flagship *Royal Sovereign*, 16 miles away.

Compound vs. Simple Locomotives in Argentina.—A correspondent from Buenos Ayres writes that the Rosario Railway has just received from England two large eight-wheeled engines for their day express between Buenos Ayres and Rosario. "Noticing," he says, "that they were *not* compounds, whereas all the recent engines for local service have been of the compound class (two-cylinder), I asked an official why this change, and he confirmed the opinion that I had formed as to the cause of the engines being 'simples,' and that was that the compounds when tried on the through expresses had shown but little economy, while on the local trains they had proved much more economical.

"It may be pointed out here that the economy of the compounds on local traffic is probably obtained to a great extent, when the engines are starting and working at nearly full stroke, it being possible to work them with direct steam in the receiver after they have made a half stroke.

"The compounds referred to for local traffic have 6-ft. wheels, and therefore lag considerably in starting, and are worked with a long period of admission for some time. The new engines have 18 × 24 in. cylinders, 6 ft. 6 in. driving-wheels, Belpaire fire-boxes, and straight boilers of a larger diameter than any other passenger engine boilers that I have seen in this country.

"WILLIAM V. BURT."

Mortality of Telegraph Operators.—Evidence was recently given before a committee of inquiry, which the *British Medical Journal* accepts with a very slight reservation, to the effect that half the telegraphists who die between 15 and 55 years are victims to disease of the respiratory organs, while the general public at the same ages suffers only in the proportion of 24 per cent. No explanation of this fact, if it be a fact, is suggested. May it not be that the cause is due to operators inhaling the fumes from batteries which are in close proximity to the places where they work ?

Clocks on Locomotives.—The Paris-Lyons-Mediterranean Railway Company has recently fixed clocks on the outside of its locomotives, on the side toward the station platforms, in order that passengers can observe the time and that the station officials can more conveniently note the exact time of arrival and departure. In spite of the great vibration, the clocks are said to show no variation.

Compound Locomotives in Germany.—As tending to show the extent to which compound locomotives are being introduced in Germany, it is reported that toward the end of last year the Directors of the Prussian State Railways decided, after exhaustive trials, to use compound locomotives for all through freight and express services, but not for suburban services or for trains requiring to make any stoppages. In order to carry this decision into effect, orders have been given for the construction of 167 compound locomotives to be supplied during the current year.

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NEW YORK, NOVEMBER 1, 1895.

EDITORIAL NOTES.

A NOTABLE marine event of the past month is the trial trip of the *St. Paul*, of the American Line, and the securing of the mail contract from the United States Government. This completes the fulfilment of the agreement between the company and the Government for the construction of two fast vessels that are to form an auxiliary navy that will be at the disposal of the Government in case of necessity, and which cost nothing to build and maintain beyond the payment of a certain sum for services rendered in carrying the mails. The whole fleet of the American Line engaged in the weekly service between New York and Southampton is now sailing under the American flag—a state of affairs that has practically existed since the *St. Louis* went into commission, though the extra steamer was still sailing under the union jack. Now, however, the four great liners, the *New York*, *Paris*, *St. Louis* and *St. Paul*, are of American register.

SINCE our last issue another battleship destined for the United States Navy has had an official trial, and has, as usual, been found to exceed the requirements of the contract, and to have earned a handsome bonus for her builders. This is no more than was expected, and is a matter to which we have become so accustomed during the past few years as to attract no particular attention and to excite no comment except on the part of those who are opposed to the payment of any bonus whatever. What has attracted attention, however, is the performances of the *Indiana* in a seaway. It was prophesied, when the designs were first made public, that the roll at sea would be so great as to be almost intolerable—a prophecy that has utterly failed of realization, for, if the reports of the run from the Delaware capes to Cape Ann are in the least reliable, there was practically no roll at all, and the *Indiana* is the steadiest battleship afloat—a fact that must cause great satisfaction to the designers and builders, especially in view of the great trouble that has been experienced with some of the vessels in the French and English navies.

IT is difficult to foretell the ultimate goal that the present tendency toward the construction of large cars will finally reach. That the "large-car" problem is one attracting wide attention is evidenced by the interest taken in it by the railroad associations. The railroads are naturally anxious to cut down dead weight and increase the paying load, the shippers are desirous of putting as much in a car as possible in order to lower rates to a minimum, and the mechanical departments are equally eager to go the other road one better by building a car of a few tons greater capacity. It does not take a very old man to remember when the 10-ton car was the standard, and the dead weight and paying load, when the car was full, were about the same. Now the ratio of paying to dead load is something more than two to one, with every one on the *qui vive* to raise it still higher. Cars of 70,000 lbs. capacity are in active service, and while there is no mechanical impossibility of raising the capacity to almost any limit, there evidently is a commercial limit beyond which it will be definitely known that large cars of heavy carrying capacity will not pay when the average available load is taken into consideration. The question is, Where is that limit?

THE NEED OF A GOOD ENGINEERING LIBRARY.

THERE was recently held in Brussels a Bibliographical Conference, the purpose of which was:

First, the foundation of an International Institute of Bibliography, having for its object the study of all questions relating to the science of book knowledge.

Second, the adoption of a universal and international bibliographical classification.

The accelerating rate of increase of literature of all kinds has made it apparent that some comprehensive system of classification is as essential to the usefulness of our rapidly growing stores of books as the books are themselves. To collect together in one building some hundreds of thousands or millions of books, without some guide to what they contain, is, as some one has said in commenting on the meeting referred to, "somewhat like placing the reader in the centre of a dense forest, and leaving him to find his way out as best he can."

This is true of general and also of technical literature, and particularly of that which relates to engineering. But in this department not only is there no classification and no guide or index, but the books themselves are not even collected together in any one place. There is nowhere in this great country where anything approximating to a complete collection of engineering books can be found. The library of the Patent Office, in Washington, is perhaps the best, and some effort has been made there to have it indexed; but owing to the unspeakable imbecility of Congress, no sufficient appropriation can be obtained from the accumulated fund which inventors have paid into the treasury of the Patent Office, for the prosecution of this important work. One of the most useful libraries of this kind is the one established by the Pennsylvania Railroad Company, at Altoona. Through the indefatigable efforts of Dr. Dudley this has had a steady growth, and the books have been collected with admirable good judgment and are available, we believe, to all reputable persons who choose to make use of them. The books are, however, stored in a combustible hotel building, and it is said that not even death and taxes are more certain than that a library thus housed will ultimately burn up. The American Society of Civil Engineers and the Mechanical Engineers each have the nucleus of a library, but the soil in which they are planted is not sufficiently fertile to produce a rapid growth.

Some years ago the subject was brought before these societies and those of the Mining and Electrical engineers, and committees of conference from each were appointed to consider ways and means of establishing a joint engineering library for the use of all four associations. Several meetings and conferences were held, at which the inability of civil engineers for co-operation with others was revealed, and although a good deal of talk was indulged in, and various members of the committees set forth, with much fervor, the importance of having a good engineering library and the value which it would be to the "profession," no workable plan was ever presented for its formation, and the movement finally died of inanition. At various times different persons have brought forward schemes for the construction of a building, in which the various societies were to be housed, each with rooms of its own, but with a common meeting hall and library. There were to be stores below and offices for engineers above, and, we believe, bachelor apartments entered into some of the schemes, but it has never appeared that any considerable amounts of money were subscribed, nor did it appear clearly in whose hands the title of the property should be vested, nor who should be responsible for its control and management. Naturally capitalists were not over-eager to subscribe to a scheme with so slight a foundation and a superstructure designed on such inadequate business principles.

The Mechanical Engineers' Library is under the control of a separate association, called the Mechanical Engineers' Library Association, the "affairs" of which, it is said in the constitution, "shall be managed by a board of nine trustees." Three of these are elected "at the first annual meeting"—presumably of the Engineers' Association, although it is is not said so in the Library Association's printed by-laws. The title to the building at No. 12 West Thirty-first Street, New York, occupied by the library and the society, is vested in the trustees of the Library Association. While this organization may be the basis for the formation of a really good library in the future, it must be admitted that at present it is not giving any very great manifestations of activity or vitality, and the prospects which it holds out for the formation of such a collection of books as engineers need is not very promising. In the mean while, the need of such a library increases day by day, and it would be one of the greatest aids to the advancement of engineering art and science that could be provided.

It will be a great waste of money and of effort if the mechanical, the civil, the electrical, and the mining engineers should each attempt to form libraries of their own. Not only many of the books, but most of the expenses of their care would be duplicated if separate libraries are maintained. Although the effort to establish a joint engineering library which was made some years ago—as has been said, died of inanition and of talk—the scheme seems to be a very practicable one, and might be carried out if a little sound business knowledge was exercised in carrying it out. Of course there is the question of where the money is to come from; but this ought to be a secondary one, in order of consideration, for the reason that before money can be obtained there must be assurance that whatever is contributed will be wisely expended. There is now so much wealth in the hands of persons who have acquired it through some of the engineering occupations that it seems certain that if it could be clearly shown that whatever was contributed for the formation and maintenance of an engineering library would be wisely expended, and would accomplish the purposes for which such a library should be formed, that there would be comparatively little difficulty in securing liberal contributions by bequest and otherwise. Men who have acquired wealth and have kept it usually have at least that kind of hard sense which would recoil from seeing, or knowing, or even suspecting that if it was devoted to any purpose it would be misused or wasted. The first requirement to unloose the purse-strings of rich people is to give them the assurance that the money, if given for the purposes for which it is asked, will be wisely employed. Therefore, before it is possible to be successful in the solicitation of money for establishing and maintaining an engineering library, some organization is needed which will provide adequate responsibility for its care and expenditure and for the conduct of the library.

In the organization of the Mechanical Engineers' Library Association such a plan is outlined. As already explained, it is provided in its by-laws that its affairs shall be managed by a board of nine trustees, to be elected by the Mechanical Engineers' Society. Now, supposing that the word "mechanical" was omitted from the title, making the organization the Engineers' Library Association, and each of the societies named above were invited to appoint, say, five library trustees, who jointly should form a board of management of a library association. It is probable that better men would be selected if these were appointed by the respective presidents, with the approval of the boards of managers or the council, than would be the case if they were elective. Such an organization would have the authority and responsibility of their respective societies back of them, which would prevent the appointment of unworthy persons, or, at any rate, if by mischance bad appointments were made, the influence of the respective societies would speedily cause such appointees to be supplanted.

Thus organized, and with such authority and responsibility, the board could devise and formulate a plan for a library, and, it may be, could make feasible the scheme of a building for the joint occupancy of the different societies, with the library as the main central feature. All this could be done without money. They could then go before the public and say, "This is our scheme; we want the money to carry it out, and we will be responsible for the conduct of the enterprise. While we are not immortal, it is presumed that our societies are; and when we fall by the way, our creators will see that competent substitutes will be appointed to fill our places."

It should be kept in mind, too, that the mere collection of books and making them accessible to readers is only a part of the purpose which a library should fulfil. To serve its purpose fully it should be completely indexed, not only by the titles and authors of books, but topically. The extent to which this may be carried, and its usefulness, is still very imperfectly understood. The accumulations of periodical literature are now almost useless on account of their enormous volume. A thorough search through such publications is now entirely impossible for busy people, and nearly so for students who devote all their time to such work. Such literature is now growing at an increasingly rapid rate. A library, therefore, should have as an adjunct an indexing department which would do much more than catalogue the books. Already considerable work has been done in this direction, and if collected together would be of very great value. Indexing has the great advantage, too, that its value is not dependent on its completeness alone. An index to one number of THE AMERICAN ENGINEER has its use; if carried over a whole year it is twelve times as valuable; and if it covered the whole period of its issue, the same proportionate increase would accrue. The indexing of the volumes of one periodical would be valuable; a hundred or more would be in like ratio.

Now, what more creditable and satisfactory monument could one or more of our millionaires create for himself or themselves than to endow an engineering library? A building, which ought to be a work of art, would be erected in some conspicuous place, with every modern appliance for the care of books and for facilitating their use and study. Two meeting halls would be provided—one large and one small one—arranged so that hearing would be easy and discussion a pleasure—facilities afforded by very few halls. These would be

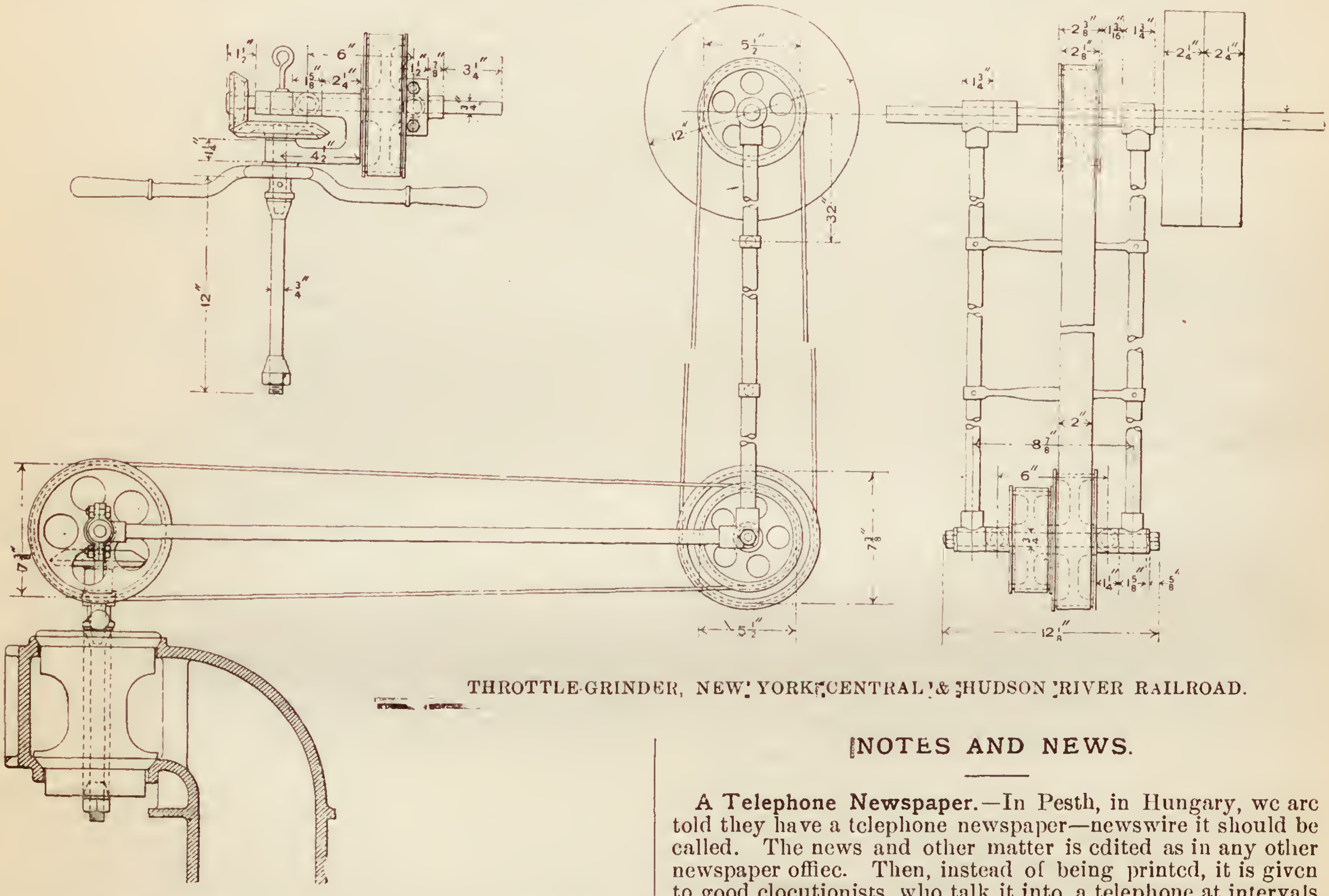
provided, too, with all needed apparatus for scientific exposition and experimental demonstration. Apartments would be provided for each of the societies named, and possibly others, and the building would contain offices for engineers, which would all yield a revenue for the support of the library. It would be possible to combine with the library an engineering museum, in which would gradually be stored specimens of all kinds, of interest to those engaged in "the art of directing the great sources of power in nature for the use and convenience of man." Such a place would be quite sure to become a centre of engineering science, art and business. An appeal is made to those who are able and inclined to devote some of their surplus wealth to a very useful purpose, and who, in doing so, could establish an enduring monument to their intelligence and beneficence.

AUTOMATIC STABILITY.

To the Editor of the American Engineer and Railroad Journal:

Sir: I read with interest Mr. Moy's letter in the June number on longitudinal stability, but cannot agree with his statement that "a mechanical bicyclist is an impossibility." One of the requirements of a good cycle nowadays is that it ride "hands off." This is accepted as a proof of superior steering qualities, although such is not necessarily the case, for some fine steerings are not "hands-off" steerers; but given a machine properly designed to make it a good "hands-off" steerer, and it will steer itself in a substantially straight line over a uniform surface till the speed dies down. It will do this whether it carries a rider or not, so it is simply a statement of fact to say that a mechanical bicyclist is a possibility, and, further, it is already an accomplished fact. It is known by most of the older riders that a "hands-off" steerer if left to steer itself will make a straighter line than if the rider attempts to steer it. Fancy riders often ride toward a handkerchief at speed, dismount backward, allowing the wheel to continue its course, pick up the handkerchief, and then follow and overtake the cycle before its speed dies or its course changes. To test the steering of a cycle, I have stood at one side of a yard, with a friend at the other side, and we have bowled the cycle back and forth between us. If this is not mechanical steering, what is? Mechanical steering is not of much value except on uniform surfaces, and I fear that it will be valueless in the air, because of the irregularity of many of the currents. The undulation and pulsation of the air current will require movement of the machine to adapt itself to the best conditions, and self-steering will not do this. In calm air or in a perfectly steady current it would serve all right, but this is where it is least needed. In cycling, beginners make no use of the self-steering feature of their cycles, because they cannot sit steadily enough. Their every motion interferes with the self-steering tendency of the machine, and it may be thus with the machine in the air. It seems most likely that it will be necessary for the aviator to take advantage of the wind continually, and to do this he must continually balance, as does the bird. Practice will make this easy, just as it has made cycling, skating, stilt-walking, and swimming possible and easy. It probably will be possible to make machines of such size and power that they will go ahead regardless of such things as wind gusts, much as our ocean steamers do to-day; but it is far more likely that success will be found in the small individual machine, where the man is a part of the craft, and where every variation of direction of air current is noted and either compensated for or made use of by the aviator.

Charles E. Duryea.



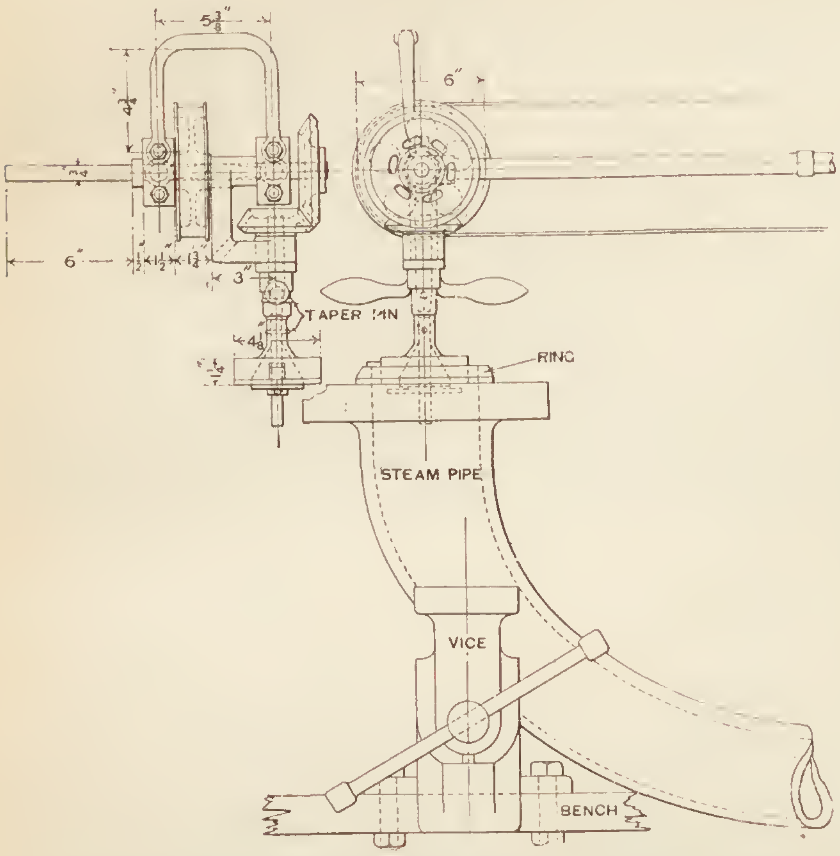
THROTTLE-GRINDER, NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

NOTES AND NEWS.

A Telephone Newspaper.—In Pesth, in Hungary, we are told they have a telephone newspaper—newswire it should be called. The news and other matter is edited as in any other newspaper office. Then, instead of being printed, it is given to good elocutionists, who talk it into a telephone at intervals during the day and evening. The receivers are connected to the main line by long, flexible wires, so that the hearer can listen in bed or wherever suits his or her will or fancy. Twenty-eight editions are uttered per day. In the intervals the recipients are entertained by music from vocal and instrumental concerts which are specially given in the office, and the wires are also connected with the opera house and music halls, and on Sundays and saints' days with the churches. The happy Hungarian, it is said, can lie abed all day and yet hear everything that is going on.

Throttle and Steam-Pipe Grinders.—In the West Albany shops of the New York Central & Hudson River Railroad there are two machines in use for grinding throttle-valves and steam-pipe joints that are exceedingly rapid and efficient workers. The construction of these machines is very clearly shown in the accompanying engravings. Both grinders are made in the same way, with a slight change in dimensions and details. The throttle-grinder, which is shown in full, con-

sists of a 1-in. counter-shaft with a tight and loose pulley, from which a swinging arm is suspended, that, in turn, is connected to a horizontal arm upon the further end of which is a pair of bevel gears driving a vertical shaft, to the lower end of which the valve is fastened. A cross-handle serves to give the operator perfect control of the movements of the apparatus, and a ring above the shafting affords a means of



STEAM-PIPE GRINDER, NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

hanging up the horizontal arm when the machine is not in use. The steam-pipe grinder is made in the same way, with a slight difference in the method of mounting the gears at the operating end, which will be readily seen by a comparison of the engravings.

The "Vzryv."—One of the Russian torpedo-boats has the above consonantial name. To pronounce it you inhale red pepper and stand on your head.

A Big Cable.—The Lexington Avenue Cable Road has recently been opened for traffic. Its cable arrived shortly before, and the *Sun* says:

"It was made in St. Louis, and cost $30,000. It is 1½ in. in diameter. It came on three giant spools. The longest section is five miles long and weighs 68½ tons. It is said that no cable of equal length in one piece has ever been brought to this city. The other two sections bring the total weight up to 128 tons. It took 52 horses and 25 drivers to transport the largest spool on a truck weighing five tons across the city to the powerhouse in East Twenty-sixth Street.

Electrical Fireproof Compound.—It is reported in the daily papers that the Secretary of the Navy, upon the recommendation of the Board of Naval Engineers and Constructors of the United States, ordered on July 24 that all war vessels built for the Government in future should be constructed as to the wood used of materials which had been treated with what is called an electrical fireproof compound.

A test of this was recently made before Mr. Constable, the Building Superintendent in New York. Two model wooden staircases were built, one treated with the new compound, which was injected into the wood, and the other was not. After being set on fire the untreated one was speedily burned up, while the other was not.

The Latest Record.—The work of smashing the world's record for long railroad runs goes on apace, and it is now held by the Lake Shore & Michigan Southern Railway. On the morning of Thursday, October 24, a train left One Hundredth Street, Chicago, at 3.29 : 27 and arrived at Buffalo Creek 11.30 : 34. The distance travelled was 510.1 miles, and the time elapsed was 481 minutes 7 seconds, making an average speed of 63.60 miles an hour. Five stops were made, and the time lost thereby was 10 minutes and 57 seconds, so that the time actually consumed in running the 510.1 miles was 470 minutes 10 seconds, or an average speed of 65.07 miles an hour. There were 24 slow downs for railroad crossings and 14 for other purposes. Eight-wheeled engines were used throughout the run except between Erie, Pa., and Buffalo, N. Y., where a 10-wheeler was employed. The details of the run are as follows:

The train left Chicago at 3.29 : 27, and made the run to Elkhart, 87.4 miles, in 85 minutes 26 seconds, an average speed of 61.32 miles an hour. There was a heavy white frost on the rails, rendering the run somewhat difficult. At Elkhart 2 minutes and 11 seconds were spent in changing engines, and the train left there at 4.57 : 04 for Toledo, arriving at the latter place, a distance of 133.4 miles, at 7.01 : 39, an average speed of 63.60 miles an hour. The time lost in changing engines here was 2 minutes and 36 seconds, and the train left Toledo at 7.04 : 07 for Cleveland, a distance of 107.8 miles. This run was made at an average speed of 60.96 miles an hour, the train arriving at Cleveland at 8.50 : 13. Only 1 minute and 45 seconds was lost here in changing engines, and at 8.51 : 58 the train started on the run of 95.5 miles to Erie, the distance being covered in 85 minutes and 32 seconds, an average speed of 67.01 miles an hour.

On arriving at Buffalo a portion of the party took the Empire State Express for New York. This train left Buffalo at 12.55 P.M. and reached New York at 10.15, after a total elapsed time since starting from Chicago of 17 hours, 45 minutes. The members of the party were met at the Grand Central Depot and driven to several places of amusement in the evening, and the Chicago morning papers were received on the day of publication for the first time. The total distance run was 980 miles, and the through time, including all stops and delays, was equal to about 56.16 miles per hour.

Draft Sheets.—At the August meeting of the Southern & Southwestern Railway Club, Mr. Michael reported on some experiments which he had made with draft sheets or smoke-box diaphragms on a 20-in. × 24-in. consolidation locomotive on the Memphis & Charleston Railroad. By a careful adjustment and use of pyrometers and vacuum gauges, it was found that the arrangement of double draft sheets, like that illustrated by the accompanying engraving, gave far better results than could be obtained with the ordinary single diaphragms. All of the "readings for each sheet were taken, as near as they possibly could be, under the same relative conditions, the engine having the same throttle opening, working in the same notch in quadrant, with the same steam pressure and at the same mile post, the tests being made on July 24 and July 26, the weather in both tests being hot, clear, and dry, and on an average grade of 70 ft. to the mile.

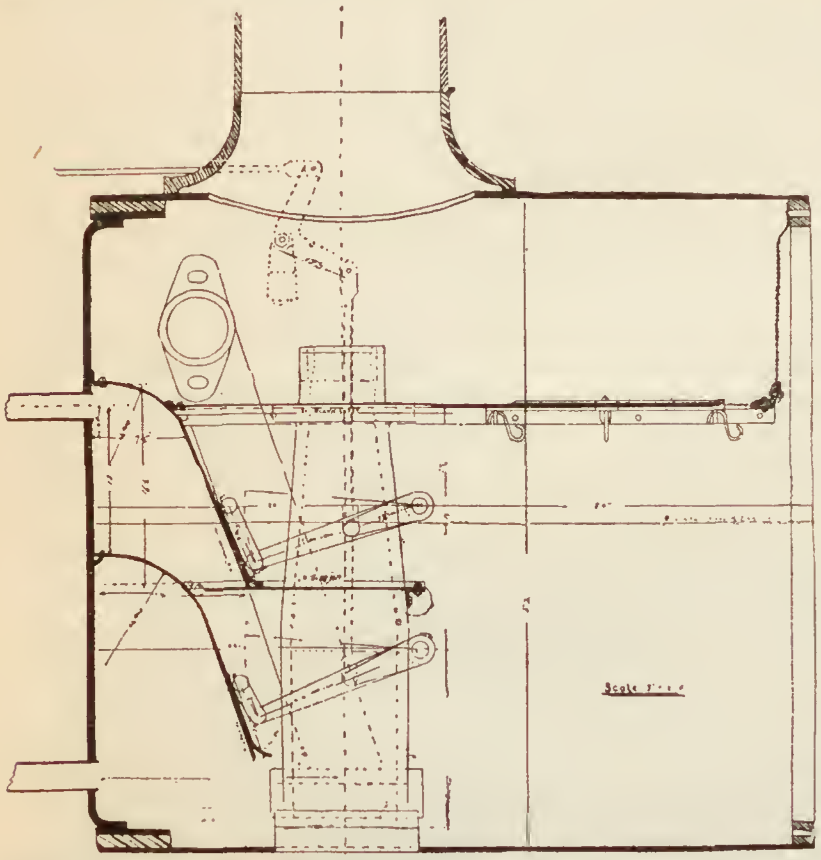
"Twelve readings were taken in each test. The 12 readings with the double draft sheet developing a temperature of 381° in the top chamber and 401° in the bottom chamber, the average vacuum in the top chamber being 2.23 in. of water in the glass, or 0.10 lbs. vacuum; in the bottom chamber 1.75 in. of water in the glass, or 0.07875 lbs. vacuum, the vacuum in the top chamber being 21.5 greater than in the bottom, and the temperature being 3.9 greater in the bottom chamber than in the top.

"Twelve readings were also taken with the single draft sheet now commonly used, under the same conditions precisely, developing a temperature opposite the top row of flues of 364°, and opposite the bottom row of flues 348°, or 4.4 per cent. greater heat at the top flues; the vacuum opposite the top row of flues being 2.15 in. of water in the glass, or .09675 lbs., and at the bottom 1.85, or 0.08325 lbs. of vacuum, being 14 per cent. greater vacuum at the top flues.

"This proves conclusively that the double draft sheet gave 13.2 per cent. greater heat through the bottom flues than the single draft sheet. The temperature being much lower with the single sheet, which I think has been the cause of the bottom flues giving us so much trouble by leaking. Making comparisons between the two sheets, you will find that the average temperature of the double draft sheet at the top is 385°, and the average temperature with the single draft sheet at the top is 364°, a difference of 21°, or 5.4 per cent. greater heat in favor of the double sheet, while the average temperature of the double draft sheet at the bottom is 401°, and that of the single sheet at the bottom is 348°, a difference of 53°, or 13.2 per cent. in favor of the double draft sheet. The average vacuum of the single sheet opposite the bottom row of flues being 1.85 in. of water in the glass, while with the double sheet it is 1.75, a difference of 0.10, or 4.4 per cent. less vacuum opposite the bottom row with the double sheet.

"It will be noticed that the temperature of the gases passing out of the flues where the two sheets are used is much hotter than with the single sheet, and with particular reference to the bottom flues to the reduced temperature in the same caused by the gases passing through the flues without being consumed, and in the case of bottom flues stopping up the tendency of fuel in them to be drawn through the bottom flues

is very materially reduced by the application of the second sheet. It is also seen that engines equipped with two sheets are saving fuel over those using the single, and this is particularly noticeable in the case of four 17 × 24-in. passenger engines running on the Memphis & Charleston Railroad, all equipped with the double sheet, alongside the same class of engines equipped with the single sheet, where a saving of coal is shown with an increased size nozzle."



DOUBLE DRAFT SHEETS, MEMPHIS & CHARLESTON RAILROAD.

The report states that the aetual percentage of coal saving is as yet unknown, but the committee is of the opinion that adjustable draft sheets are certainly an important factor in economical consumption of fuel, in decrease of repairs due to leaks of flues, in cleansing of flues and consequent better steaming, and also that the cost of introduction of such an element of economy is infinitesimal when considered with the results obtained.

The New Battleships.—In our issue for September we published a brief notice of the new battleships for which bids are asked by the Government. Since the publication of that notice the Navy Department has given out more complete information regarding these vessels, the details of which we reproduce from the *Army and Navy Journal* :

"The general dimensions of the Department design on load-water line at normal displacement of 11,500 tons are: Length, 368 ft.; moulded breadth, 72 ft.; mean draft, 23 ft. 6 in.; total coal capacity, loose stowage, 1,210 tons; coal carried at normal displacement, 410 tons. It is contemplated to drive the vessel by twin screws. The engines are to be of the vertical triple-expansion type, two in number, in two separate compartments. The five boilers to be of the cylindrical double-ended pattern, three in number, and two single ended boilers to be placed in four compartments. Any alternate design of machinery submitted by contractors must fulfil the general requirements contained in the 'Specifications to be followed by Contractors for Machinery' issued by the Bureau of Steam Engineering.

"If, on trial, the average speed shall equal or exceed a speed at sea of 16 knots per hour for four consecutive hours, the vessel will be accepted in so far as the speed is concerned. If the speed falls below 16 knots and exceeds 15 knots per hour, the vessel will be accepted at a reduced price, the reduction being at the rate of $100,000 per knot speed below 16 knots. If the speed falls below 15 knots per hour, the vessel will, in the discretion of the Secretary of the Navy, be rejected or accepted at a reduced price mutually agreed upon between the Secretary and the contractors. In case of rejection any money that may have been paid to the contractors on account shall be refunded. The time that will be allowed for the construction of these vessels will be three years from the date of signing the contract. The hull is to be of steel, not sheathed, with double bottom and close water-tight subdivisions. There will be two military masts with fighting tops, to carry no sails.

"There will be a side-armor belt 15 in. thick with a mean depth of 7 ft. 6 in., extending at least from the stem to the after barbette, and to maintain this maximum thickness throughout the engine and boiler spaces; from thence forward it may be tapered gradually to a thickness of 4 in. The transverse armor at the after end of the belt, and just forward of the boilers, will be not less than 8 in. thick. Barbettes for 13-in. guns will have armor not less than 15 in. thick, except in rear, where it will be reduced to 12 in. The turret port plates to be 17 in.; the balance of the armor-plating 15 in. thick. The ship's sides from the armor belt to the main deck will be protected by not less than 5 in. of steel armor from barbette to barbette. Coal is to be carried back of a portion of this 5-in. casemate armor. An armored deck is to extend throughout the length of the vessel, not less than 2¾ in., but with slopes 3 in. thick. A cellulose belt is to be fitted along the sides the whole length of the ship. A conning tower of not less than 10 in. in thickness, having an armored communication tube not less than 7 in. in thickness, will be carried in a suitable commanding position, the tube extending to the armor deck and affording protection to voice tubes, bell wires, etc. The 8-in. gun turrets will be superposed on the 13-in. turrets, and the armor will be not less than 11 in. in thickness on the port plates and 9 in. elsewhere. In wake of the 5-in. guns on the main deck is to be continuous armor 6 in. thick extending between the turrets. Further protection is to be afforded by splinter bulkheads between the guns, 2 in. thick, extending from deck to deck. Protection is to be afforded the smaller guns by shields and extra side-plating.

"The total coal-bunker capacity must not be less than 1,210 tons, stowed in bunkers without trimming by hand, of which at least 410 tons are to be carried at normal displacement. The electric-lighting plant should consist of three units, each dynamo having a rated output of 400 ampères at 80 volts. The total weight of the three units complete should not exceed 31,500 lbs., and the total weight of the whole electric installation 44 tons. The battery of the vessel is to be four 13-in. breech-loading rifles, four 8-in. breech-loading rifles, fourteen 5-in. rapid-fire guns, twenty 6-pdr. rapid-fire guns, four 1-pdr. rapid-fire guns, four machine guns, one field gun. The supply of ammunition is to be as follows: Two hundred rounds 13-in. ammunition, 500 rounds 8-in. ammunition, 3,500 rounds 5-in. ammunition, 10,000 rounds 6-pdr. ammunition, 2,400 rounds 1-pdr. ammunition."

The "Nashville" and the "Wilmington."—These two vessels have been recently launched at the yards of the Newport News Shipbuilding Company. The *Nashville* is a light-draft twin-screw gunboat designed for the usual duties of cruising naval vessels. In coast work her moderate draft of water will enable her to enter many ports from which most men-of-war are excluded on account of their greater draft. She is 220 ft. long on the water-line, with 38 ft. beam. At her normal draft of 11 ft. her displacement is 1,371 tons. She is schooner-rigged, with two smoke-stacks, and her total coal-bunker capacity is 390 tons. She has two types of boilers, cylindrical and water-tubular. She will be able to cruise without recoaling for long periods at moderate speed, using her cylindrical boilers only, being able rapidly to increase her speed to its extreme limit by starting fires under her remaining boilers. No attempt has been made to secure over 14 or 15 knots a hour, that being sufficient for the duties required of such a vessel. The engines driving the twin screws are of the quadruple-expansion type, so designed that the low-pressure cylinder can be disconnected when the vessel is cruising under ordinary circumstances. When running at full speed the high-pressure cylinders receive steam from the Yarrow boilers directly, while the two cylindrical boilers supply steam to the receivers between the high and first intermediate cylinders. At moderate speed, the low-pressure cylinders being disconnected, steam can be supplied to the two triple-expansion engines so formed by either of the batteries of boilers. The main battery consists of eight 4-in. breech-loading rapid-fire guns, four of them being on the upper deck; two 1-pdr. rapid-fire guns and two Gatling guns. One fixed torpedo tube is mounted in the bow, and a searchlight is placed just above the pilot-house and forward of the foremast.

The *Wilmington* has been built for entirely different service. Although in every respect a perfectly safe seagoing vessel, the *Wilmington* and her sister ship, the *Helena*, whose launch will not take place for several weeks, are designed especially for river service. In external appearance the *Wilmington* resembles a small battleship, having a large military mast with two military tops, similar in all respects to the one on the battleship *Iowa*, which serves to command the banks of a river or houses in a town where she may have to prevent rioting. A conning tower on the mast, just below the first

military top, enables the ship to be manœuvred at a height of 45 ft. above the water-line. The space available for quarters is large, and affords berthing capacity for many additional men besides her crew. To facilitate landing a large body of men she has boats of an unusual size, her steam cutter and sailing launch being each 33 ft. in length, or as long as those supplied to the heaviest battleships. The machinery consists of triple expansion twin-screw engines. The total coal-bunker capacity is about 280 tons. Two rudders are provided, one ahead of the other, so arranged that it may be possible to run the vessel into a bank and let her swing around with the current when turning in narrow channels. Her battery is the same as that of the *Nashville*, and she has a searchlight on her military mast, but no torpedo tubes.

In the launching of these ships there was a peculiarity deserving of especial mention. It is, we believe, the first case where two warships were launched on the same day from a single set of ways. The vessels had been constructed one ahead of the other, tandem fashion, upon a continuous decline, the *Nashville* nearer the water, with her bow a few feet from the *Wilmington*, both vessels taking the water stern foremost. This arrangement was due to the fact that the works of the contractors, in accordance with modern notions, had been installed for the erection of ships of the largest size, the building slips being of sufficient length to accommodate a vessel 500 ft. long, while the combined length of the *Nashville* and *Wilmington* is only 485 ft. 3½ in. Not only was ample space available for both ships, but it was also possible to deliver in position all the material used in their construction by a single crane, which travelled alongside on a track 80 ft. above the ground. This great crane, with a lifting capacity of 60,000 lbs. at the end of its 125-ft. arm, also served an adjoining similar slip, from which the steamer *Newport News* was recently launched. The *Nashville* had to travel only 250 ft. before floating freely, but the *Wilmington's* sternpost had 280 ft. to slide before reaching the water and 175 yds. altogether before she was fully floated, the constructors having estimated that in this descent she would attain a velocity of 11 knots an hour, which is nearly equal to her best steaming speed. On account of this unusual trip for a ship to make out of her element, special precautions had been taken in the construction of her supporting cradle to obviate any derangement while in motion. Under the *Nashville* the sliding ways were 157 ft. long, 19 in. broad, and 15 in. thick, while under the *Wilmington*, the thickness remaining the same, the breadth was increased to 25½ in. and the length to 176 ft.

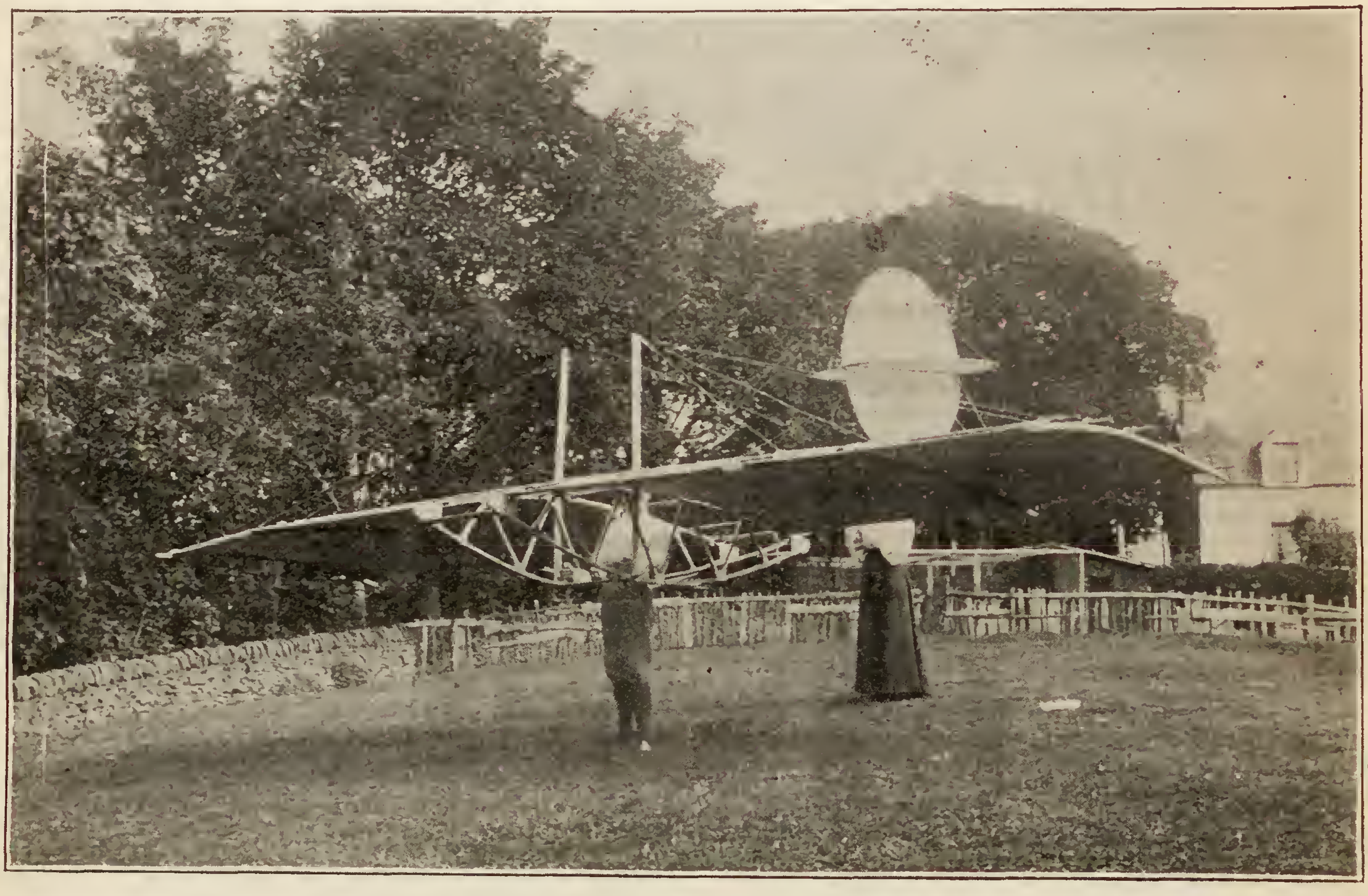
ELECTRICITY AT THE PARIS EXPOSITION OF 1900.

In a recent issue of the *Proceedings of the Society of Civil Engineers of France*, M. G. Dumont gives a *résumé* of what was done in the way of electric lighting and power transmission at the Paris Exposition of 1889, at Chicago in 1893, and at Lyons in 1894. Basing their operations upon the experience gained at these exhibitions, the directors of the Paris Exposition of 1900 have outlined their plans in a bulletin issued a short time ago. In reference to this matter, M. Dumont says that it appears then, that, thanks to the precedents thus established and the degree of perfection attained in the construction of dynamos and motors, that it is absolutely the proper thing to do to have recourse to electricity in 1900 for the complete organization of a service that shall include the lighting and distribution of power to the exhibitors. In a general way it is understood that this double service will include several central generating stations, which shall themselves be exhibitions of boilers, steam-engines, and dynamos. Some will be devoted to the production of a continuous current, and others to the alternating current. From these generating stations the conductors are to run out either underground or overhead for the distribution of the necessary lighting or power current. The public will thus be in a position to arrive at the exact value of the different systems that are in use.

It is expected that the total amount of power required in 1900 for these several systems will be about 8,000 H.P. for motors and 12,000 H.P. for lighting. It is further expected that in the evening the stations will be called upon to supply the full quota of light and about one-quarter of the motors that are installed.

Adopting the ratio of efficiency of 70 per cent., as given by the Lyons installation, for the power absorbed by the motors, the mechanical power required for the work will be $8,000 \div .70 = 11,400$ H.P. for the distribution of power instead of the 5,500 H.P. used for this purpose in 1889 ; and $12,000 \div .70 = 17,100$ H.P. for the lighting circuits instead of the 4,000 H.P. required in 1889 to light one-quarter only of the area of the exposition grounds. This gives a total of 28,500 H.P. that will be required if all of the lamps and motors are working together.

Practically (unless accumulators are used) the machines ought to furnish 11,400 H.P. to the motors during the day,



PILCHER'S FLYING MACHINE, FRONT VIEW.

and in the evening, from seven o'clock till midnight, 2,900 H.P. to the motors and 17,100 to the lamps, or a total of 20,000 H.P.

In this case it is proposed that the generating plants should consist of 40 units of 500 H.P. each, of which one-half shall be at rest during the day, thus leaving a machine at rest on exhibition by the side of its duplicate which is in motion. By the use of accumulators it would be possible to install a smaller number of units which would develop their full power from early morning until the closing of the gates, say from about nine o'clock until midnight. Under these circumstances the engines would supply the power required for driving the motors and charging the accumulators between the hours of nine and seven; while in the evening the engines and accumulators would supply the 20,000 H.P. indicated.

A calculation of the expense of installation of the two systems has shown them to be about the same, but with a slight difference in favor of the use of accumulators; but if accumulators are useful in a plant containing only a small number of motors, because the power is very irregular, they will hardly be justified in an exposition which will include a large number of motors, each representing only a very small percentage of the total power. Furthermore, the consumption of coal will be less if engines are exclusively used, since 11,400 H P. will have to be furnished during the day for 10 hours, and 20,000 during the evening for five hours, making a total of 214,000 H.P. hours; while with the accumulators 225,000 H.P. hours will be required.

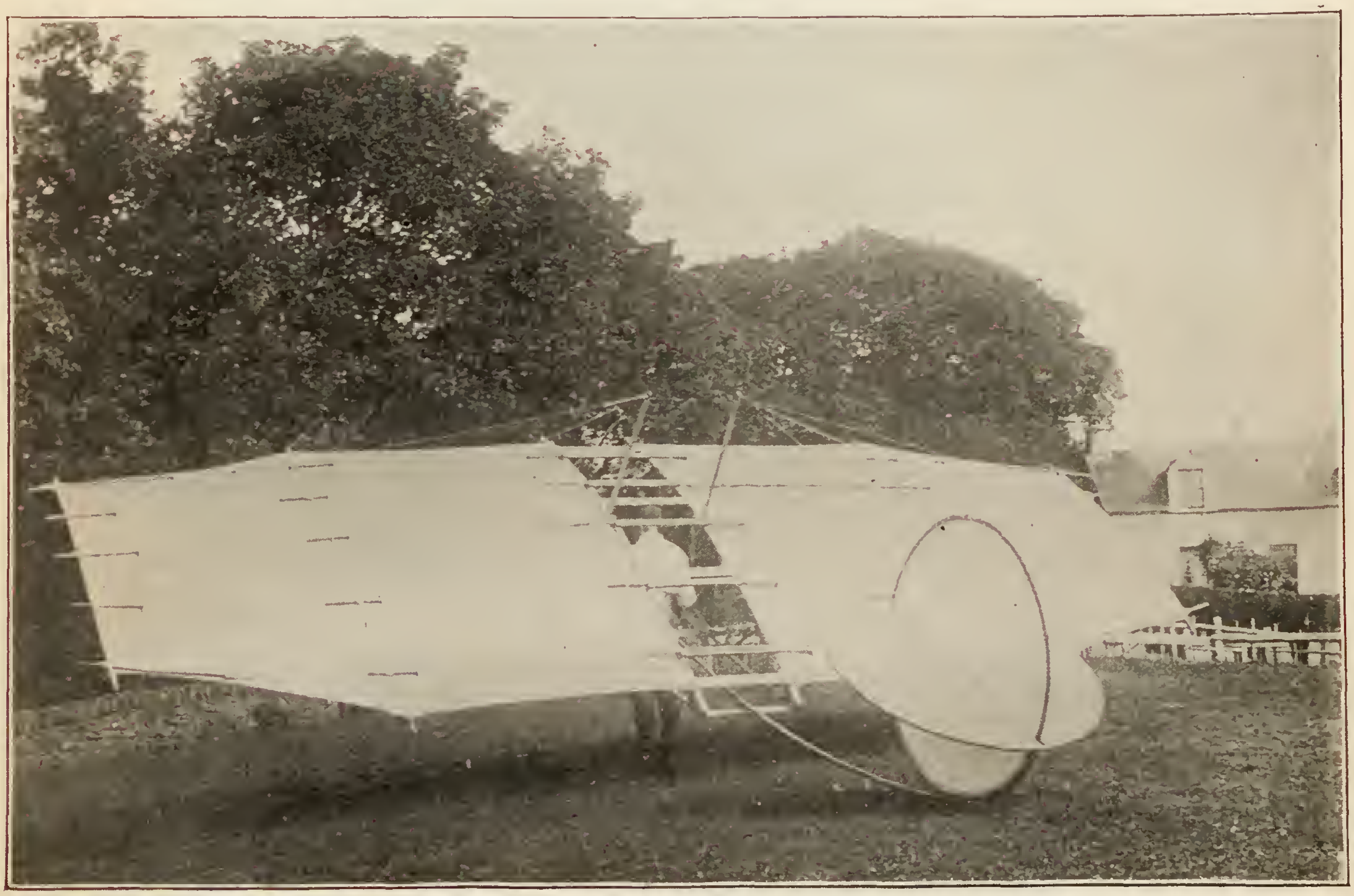
But if it is finally decided that it is not advisable to use accumulators in the production of the energy required in the general system of distribution, they will be valuable for exhibitors who can charge batteries by connecting them to the main lines leading to the lamps and motors. They can then be discharged at will by the exhibitor, for whom they will constitute a sort of reservoir of electricity. It will be with the aid of these accumulators that will form, as it were, substations, that experiments of the greatest interest can be made in view of the visitors, showing the various uses to which accumulators can be put, the method of charging and discharging, making connections, etc., and at the same time permitting them to ascertain the space required and the method of installation for each type.

We have already said that the central electric stations will be made interesting exhibits of boilers, steam-engines, gas-engines, etc. The value of these exhibits will be increased by the fact that it will be possible to make a comparison of the conditions of installation, running efficiency of engines, and gas-engines.

It is, therefore, expected that the central stations will be equipped by exhibitors, and that they will furnish the current required to the exposition; that the management of the exposition will construct the system of wiring for the distribution of the current; that the electricity thus made available will be sold to the contractors who assume the responsibility of distributing it to individual exhibitors for lighting and to supply the lamps used for general illumination; that the location and wiring of the motors required by the exhibitors will be undertaken by the contractors, who will have the concession for supplying the current needed by the exhibitors for the operation of their motors.

PILCHER'S FLYING MACHINE.

In our August number we published engravings on pp. 386 and 387 of Mr. P. S. Pilcher's first soaring machine. The tips of the wings, as first constructed, formed a diedral angle, and were about 4 ft. above the body piece when the machine was horizontal. Since the publication of these views it has been altered, and the tips of the wings are now only about 6 in. above.



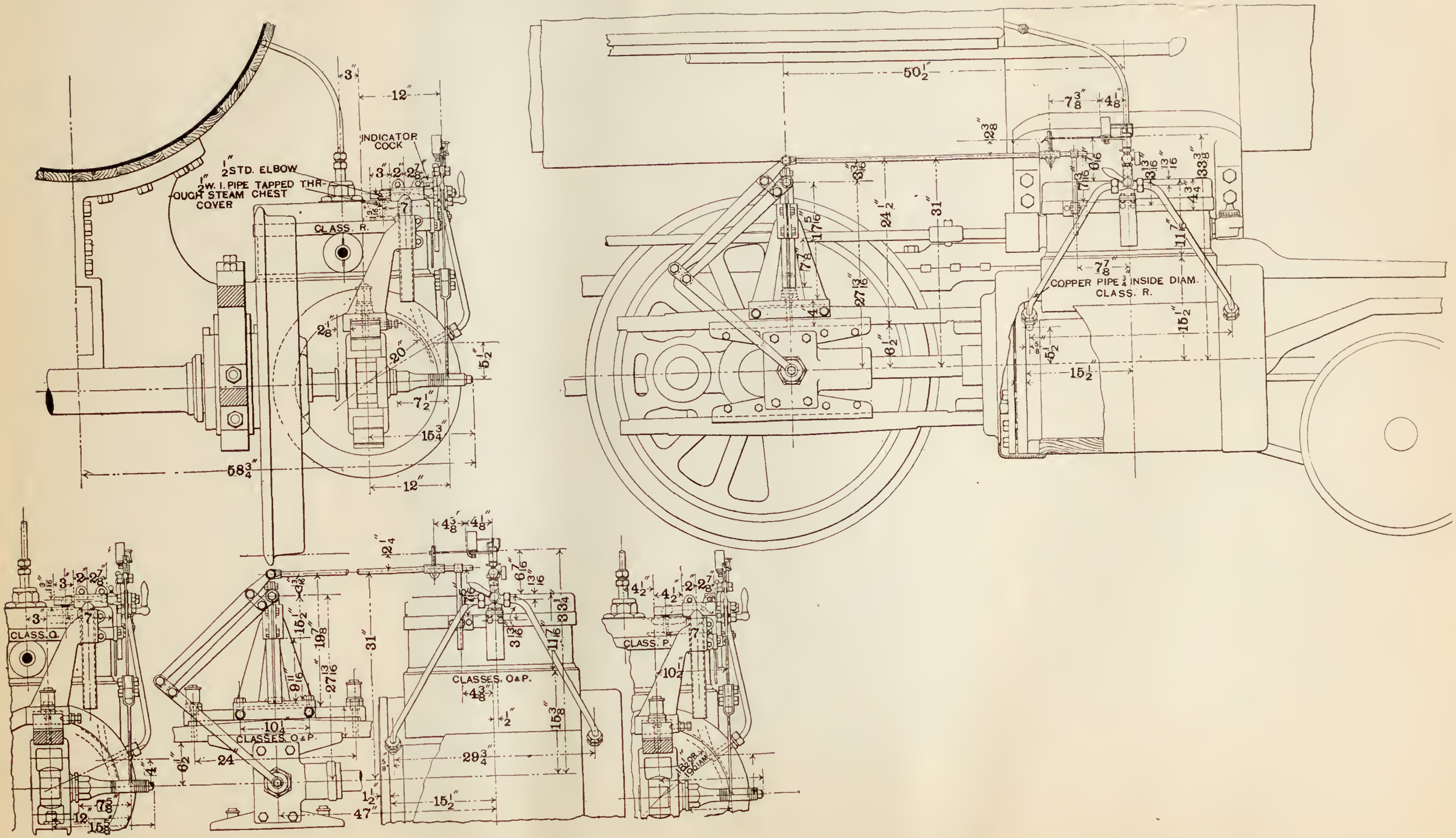
PILCHER'S FLYING MACHINE, REAR VIEW.

This alteration has made a vast improvement in the ease of handling the machine; a side puff of wind has now only a very slight tendency to incline the machine, whereas before the wings were lowered it was exceedingly difficult to keep the machine upright if the wind was not exactly ahead.

As a result of this alteration it has been possible to make trials in heavier winds, and consequently better flights have been made. Mr. Pilcher was on September 12 picked up from the ground, taken up 12 ft., and landed after spending nearly half a minute in the air; and later on the same day—after the wind had gone down a little—a line was tied on to the front of the machine, and a man ran with this; the result was that the machine, with Mr. Pilcher in it, went 20 ft. into the air, and was away from the ground nearly a minute.

The two engravings herewith show Mr. Pilcher's second machine, which has about 170 sq. ft of surface and is of a strong build; the body piece is of white pine and the ribs bamboo.

This machine has, however, two impediments against it: Firstly, it is too heavy—weighing 80 lbs.—and it tires out the



INDICATOR RIGGING IN USE ON THE PENNSYLVANIA RAILROAD, APPLIED TO CLASS O, P AND R LOCOMOTIVES.

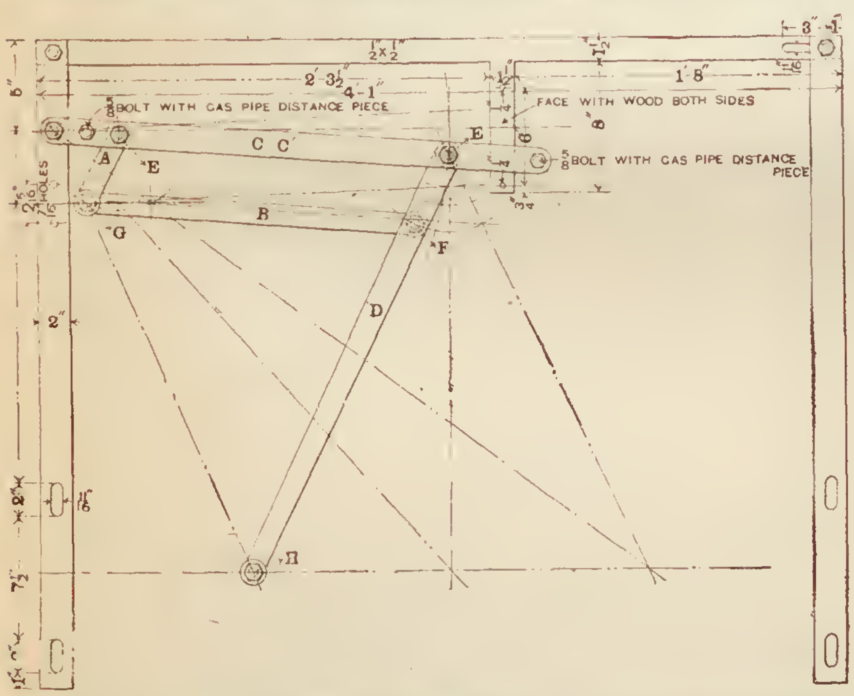
experimenter very soon; secondly, the sails are too high with reference to the operator, which, although having the advantage of keeping the wing tips farther off from the ground, makes the machine very difficult to handle.

Mr. Pilcher is now making a third machine for trials on very still days, with a sail area of 300 sq. ft. and a very light structure.

INDICATOR RIGGING APPLIED TO A LOCOMOTIVE ON THE FLINT & PÈRE MARQUETTE RAILROAD.

INDICATOR RIGGING FOR LOCOMOTIVES.

We illustrate two arrangements of indicator rigging for locomotives that are successfully used upon the Pennsylvania and the Flint & Père Marquette Railroads respectively. They are of the same type, and differ merely in the arrangement of some of the details and the dimensions. From the half-tone reproduction of the photograph, which was taken from one of



INDICATOR RIGGING USED ON THE FLINT & PÈRE MARQUETTE RAILROAD.

the Flint & Père Marquette locomotives, and the detail drawing of the apparatus it will be seen that it is made for application to an engine with four bar guides and is somewhat less expensive to make than that used on the Pennsylvania engines. The supports are merely 2 in. × ½ in. bars of iron fastened with two ⅝-in. bolts and a strap to the ends of the guides. This has ample strength for the strains that are put upon it, but it seems as though there would be considerable vibration at the upper ends when the engine is running at high speeds. This would be obviated by the arrangement in use upon the Pennsylvania engines, where a cast stand is bolted to the upper guide, and is of such shape and weight as to avoid vibration. It is more expensive to make, however, and cannot be as readily adapted to various types of guides.

The photograph of the Flint & Père Marquette locomotive shows the convenient arrangement of bracket for the operator that is used. A careful examination will show that the whole rigging can be lifted off by merely taking out the bolts that pass through the front bar and the strap running along the inside of the steam-chest. Where an elaborate series of tests are to be made at high speeds and extending over a long time, it is desirable that there should be a hood or fender at the front to protect the operator from the wind, but where the indicator is to be used merely to study the action of the valves and the steam distribution at different points of cut-off and speeds, this portable device is just the thing to use. It is light, almost universally applicable, and can be put in position by the operator without assistance. The railing and uprights are of gas pipe, and the other parts of light flat iron.

The engraving of the Pennsylvania rigging shows it applied to one of the standard class R locomotives of the company with two-bar guides. A single three-way cock is used for admitting steam from either end of the cylinder to the indicator, and the pipes leading thereto are made as short as possible, it having been found that there is no appreciable advantage in accuracy gained by the use of two indicators placed near the ends of the cylinders, while the inconvenience of manipulating two instruments and the extra attachments that must be made is a nuisance.

The dimensions are given with such completeness on both of the detail engravings that any one can very readily reproduce them for his own use, and a recapitulation of them is therefore unnecessary.

A FLY-WHEEL ACCIDENT IN HOBOKEN.

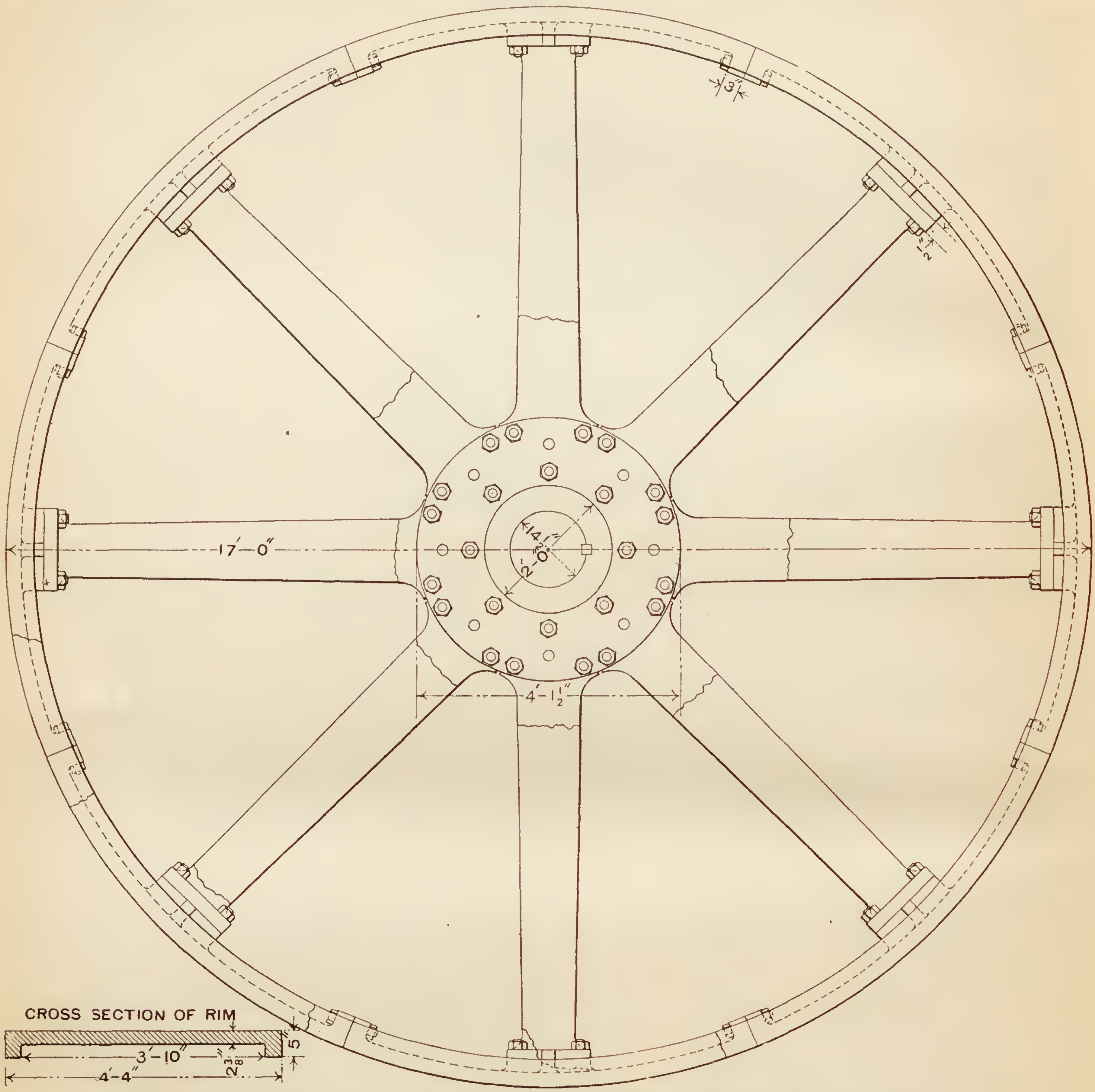
At about half-past three on the morning of Saturday, October 5, a fly-wheel 17 ft. in diameter, in the plant of the Hudson Electric Light Company, in Hoboken, N. J., burst, killing one man instantly, and injuring two others. The wheel belonged to a 500 H.P. vertical compound engine that was built by the Philadelphia Corliss Engine Company. The cause of the accident is supposed to have been the racing of the engines, as they began to do this just before the accident. At the time the engineer was on the upper platform, closing the throttle, and in a direct line with the motion of the wheel.

The accompanying engraving shows the construction of the wheel in all of its details. It will be seen to have been built up and composed of eight spokes bolted in between flanges that formed a portion of the hub, and at the outer ends these spokes were bolted by four 1¾-in. bolts to the centres of the segments forming the rim. These segments were 52 in. wide and about 6 ft. long, and were bolted together at faced flanges by eight 1¾-in. bolts. The flanges of the hub were 2¾ in. and 3 in. thick, and stood 6 in. apart between their inside faces. The wheel was entirely broken up, and the pieces were thrown out in a line with its working position to a distance ranging from a few feet up to 150 ft. All of the fractures appeared to be clean breaks through metal that was apparently sound except for an occasional blowhole. The normal speed of the engine was 100 revolutions per minute. The inner ends of the spokes were held to the flanges of the hub by three 1¾-in. bolts to each spoke; the spokes, however, were not in contact with each other, there being a space of about ¾ in. between them.

As we have said, the accident is attributed to the extra strains set up in the metal by the racing; but if this is the case, it would seem that the wheel was running very close to its limit of safety.

The normal speed that was used would produce a circumferential velocity of 5,340 ft. per minute, and this would re-

sult in a centrifugal force of about 29 to 1, giving an actual strain on the metal of about 2,760 lbs. per square inch of section—a strain that certainly is not excessive, and is so far below the elastic limit of metal that should be used, that the break cannot have been caused by bad designing and abnormal strains due to excessive velocity. It would seem, then, that the metal must have been intrinsically weak, notwithstanding the clean, close-grained appearance of the fracture. This is given merely as a conjecture to explain the cause of the accident, and without any definite data regarding the actual quality of the metal that was used. The breaks shown are a few of those that occurred in approximate positions only.



FLY-WHEEL THAT BURST AT THE PLANT OF THE HUDSON ELECTRIC LIGHT COMPANY, AT HOBOKEN, N. J.

ROPE AND BELT TRANSMISSION.*

By V. Dubreuil.

The striking feature in the use of ropes is the uniformity of motion, the absence of noise, even at the fastenings, when the ropes are well maintained, and the sensitiveness of all of the strands the moment anything abnormal occurs in the power or the resistance.

Let an overloaded motor work irregularly; let a condenser choke up or empty while starting or stopping; let the resistances be ever so variable, and we will see the ropes oscillating, storing up, by their elasticity, the variations of speed or effort, while the receiving lines of shafting do not vary in the regularity of their motion; provided, of course, that the variations of power and resistance are not too great.

This peculiarity has been of great service in very many cases, especially in transmissions that are driven by gearing and by rigid shafting whose motion cannot be regulated.

Ropes are also of great service where the two lines of shafting to be connected are not perfectly parallel. We can then open the grooves, work the strands crossed, and carry the power off in almost any direction.

Diameter of Pulleys and Ropes.—The resistance due to the stiffness of the ropes being represented by the formula $R = .104 \dfrac{a\,d^2}{D}$, in which R is expressed in pounds; a, the tension on the rope, in pounds; d and D, the diameters of the rope and pulley respectively, in inches. From this we see that D increases in proportion as d and R are less.

Linear Velocity.—In rope transmissions, the linear velocity per second should not be less than 26 ft. per second, or more than 82 ft. For belting, this speed may drop as low as 10 ft.

* Abstract of a paper read before the Society of the Civil Engineers of France.

by increasing the breadth proportionately; but it is best not to have the speed exceed 65 ft. Above 65 ft. for belts and 82 ft. for ropes the centrifugal force, which up to this point is unfavorable to the adherence of the belts and favorable, on the other hand, to that of the ropes, now becomes unfavorable to both.

Distance between Pulleys.—On account of the coefficient of friction, which is 25 per cent. greater in the case of ropes than of belts, as we shall show later on, ropes work best when slack and belts when under a tension. Consequently long distances are more favorable to ropes than to belts, the weight of the rope in the case being a factor that is favorable in assisting to free it from the grooves. Hence these distances may vary from 20 ft. to 100 ft. for ropes without an intermediate support, and from 13 ft. to 50 ft. for belts. In my own practice I have set up a rope transmission with a span of 328 ft. and only one intermediate support; others of 16 ft. that have been running since 1877, and still others of only 11½ ft.; but these are very exceptional.

Position of the Slack and Tight Strands.—Contrary to the usual opinion, I consider that it is preferable in most cases, and when it is possible, to place the driving strand of the rope on top, in order to utilize the good effects of the centrifugal force and also the weight of the rope to assist in lessening the amount of power absorbed. Nevertheless, when the distance between the centres of the pulleys is less than 23 ft. or 26 ft., and again when the ratio between the diameters of the pulleys is less that 1 to 3, it is better to place the driving strand at the bottom if it is possible to do so. In some tests made by the Industrial Society of the North of France, the driving strands of the cables were placed above; the ratio of the pulleys was as 3 to 10 for 160 H.P. developed at the piston; the diameter of the ropes was 1¾ in., and the slipping did not exceed 0.329 of 1 per cent., while it varied from .78 to .964 of 1 per cent. with belts.

Ratio of Pulleys.—Under no circumstances should the diameter of the smallest pulley be less than 30 times the diameter of the cable, and it is well not to drop below 1 to 4 for the ratio between the diameters of the pulleys.

Kind of Ropes.—Ropes should be of three-stranded Manilla hemp or of cotton. Manilla seems to be preferred in Ireland, while cotton is given first choice in Manchester. Hemp is much cheaper than cotton, and, in most cases, is more durable, instances being known to me where it has run for more than 10 years in industrial establishments; but while cotton is the more expensive, it is the more pliable.

Diameter of Ropes.—The diameter of the ropes varies with the nature of the installation and the diameters of the pulleys. The large ropes of from 1½ in. to 2 in. in diameter have the advantage of requiring a smaller number of elements than the smaller; but as the small ropes can work under a strain per square inch almost double that of the large, it sometimes happens that it does not need more small ropes for an installation of reasonable dimensions than it would of the large. So that this matter of size is largely one of convenience.

Number of Ropes.—The number of ropes varies with the material used, its diameter, and the strain which the rope can be made to carry per square inch of section. It also varies with the nature of the industry. Thus, for a given H.P. developed, only one-third as many ropes are required for driving a woollen carding or combing-room as for a cotton spinning-mule with a self-acting frame.

Sectional Area of Ropes.—In a rope it is necessary to make a distinction between the apparent and the actual diameter. In practice I have followed this rule:

$$S = \frac{\pi D^2}{4} \times 0.65,$$

S being the sum of the cross sections of the three strands and D the apparent diameter of the rope.

The Wear of Cables at Work.—It is necessary to pay attention to the stretch and wear of cables while they are in use. This stretch, which lessens the diameter, depends upon many things: the nature of the material, the care exercised in manufacturing, work of the rope, etc. Thus it is well to order ropes with a diameter of from 12 to 15 per cent. greater than their useful diameter.

Pulleys.—The pulleys should be perfectly balanced upon ways and not upon centres. The grooves should be exactly alike, as well as the corresponding diameters of the two pulleys that are next each other. Each groove should be cleared of metal, so that the rim may be as light as possible, and not create, by the multiplication of these pulleys, a sum total of active energy that may, at a given time, especially when the motor is being stopped or started, neutralize the action of the fly-wheel and cause accidents.

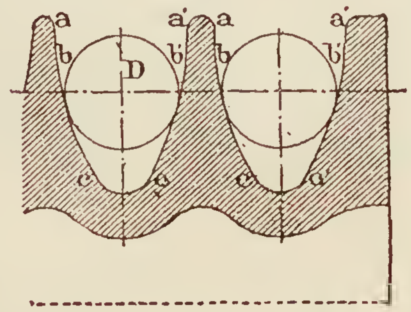
In general, pulleys with grooves of from 1¾ in. to 2 in. should not exceed a weight of 5½ lbs. per inch of diameter of pulley per groove. Thus, for a pulley 80 in. in diameter and having four grooves, we have 80 × 5.5 × 4 = 1760 lbs. This rule varies for pulleys of from three to six grooves, and for ropes of from 1¾ in. to 2 in., and is also modified in other cases. Thus, for a single-groove pulley for 1¾ in. to 2-in. ropes, the weight will run up to 11 lbs. per inch of diameter instead of 5½ lbs.; for a two-groove pulley it may be from 7 lbs. to 8 lbs.; for an eight-groove pulley with single arms it may be 4¾ lbs. For ropes of smaller diameter, the results just given should be multiplied by from .65 to .85, according to circumstances.

It will be seen that these rules are entirely empirical, and their only object is to render it possible for the engineer or proprietor to make some calculation in advance as to the results upon which he can rely.

Shafting and Bearings.—All works on mechanics give formulæ for calculating shafting and hangers. These formulæ do not take sufficiently into account the enormous tensions which are produced when new ropes are put into position or when they are wet, so that it is necessary to increase these coefficients. It should be borne in mind that the diameter of a shaft carrying a grooved pulley must never be made less than from 3 in. to 3½ in., for the mere fact of the presence of this pulley, is a warning, were it only called upon to transmit a hundredth of a H.P.

Form of Grooves.—The diameter of the cable fixes the dimensions of the groove, but the shape should be in accordance with the following rule:

The section is composed of two vertical, parallel, or oblique portions, $a\ b$, $a'\ b'$, connecting with two curved portions, $b\ c$, $b'\ c'$, ending in straight lines that are inclined to each other at angles of from 38° to 48°, according to the use that is to be made of the grooves, and finally of an arc of a circle connecting the two curves $b\ c$ and $b'\ c'$.



GROOVES FOR ROPE PULLEYS.

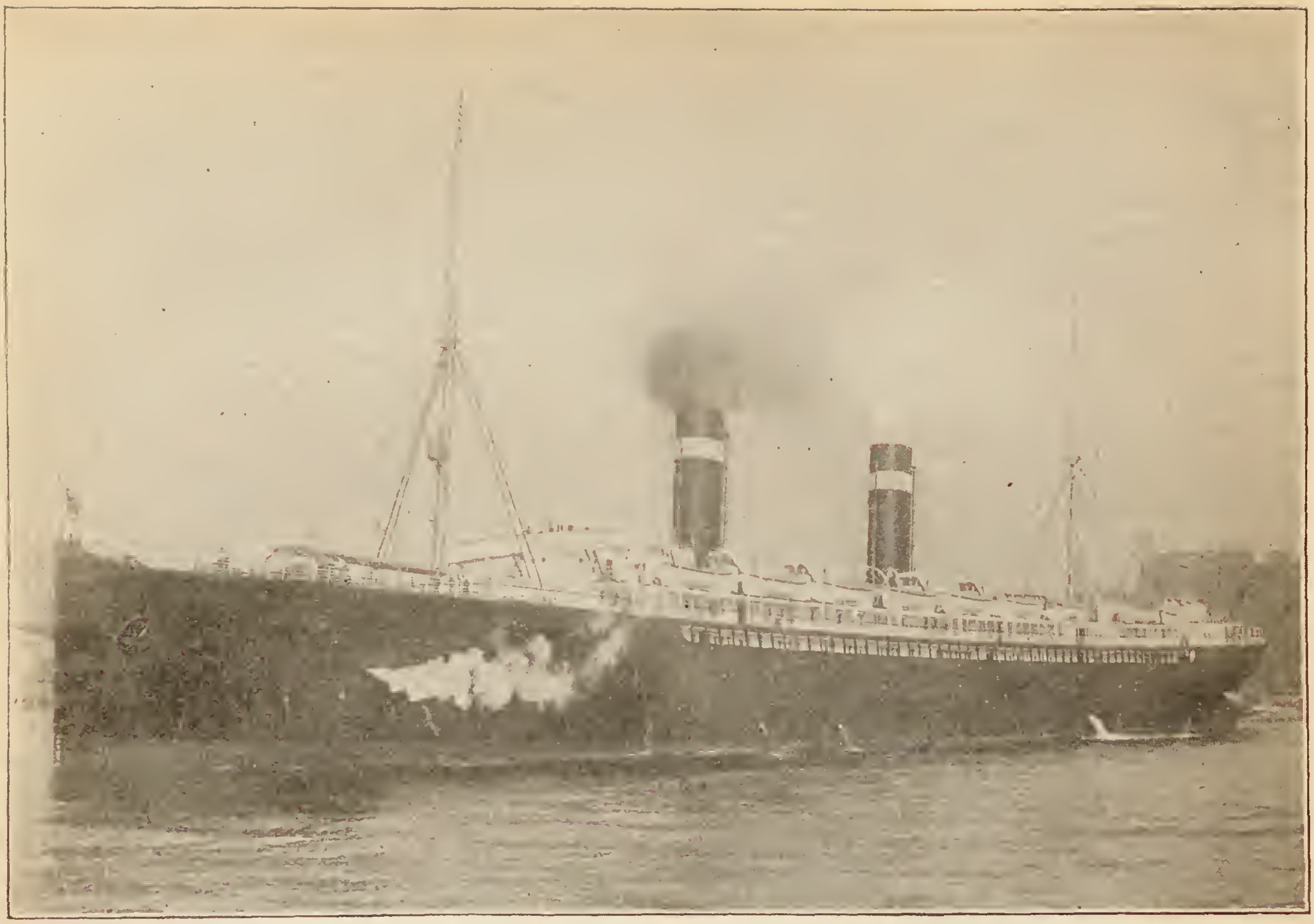
An angle of from 45° to 48°, which gives the lowest coefficient of friction, is well adapted for use with horizontal ropes; one of from 42° to 44° for ropes that are more or less inclined, an angle of 43° being best adapted for inclinations of 45°, and one of from 38° to 41° for ropes rising from 50° to 90°.

Theoretically the ropes should never be allowed to touch the bottom of the groove; they ought in service to be wedged in the V portion of the groove, so as never to be subjected to a slipping of more than .35 of 1 per cent. Disintegration of the filaments will result from a greater slipping, and it is apt to occur both at the starting and stopping of the ropes.

Oiling the Ropes.—It is well to grease the ropes to a moderate extent, so as to make them pliable, but not so lavishly as to cause them to slip; and this is one of the most delicate things to be attended to in the maintenance of ropes. Castor-oil used moderately once or twice a month is recommended for hemp ropes. As for cotton ropes, there are many compositions upon the market that are contending for the first place in industrial establishments. As a general thing, however, when such a rope is well used it is unnecessary to grease it.

Friction of Ropes and Belts on Pulleys.—Some time ago the Messrs. Parce Brothers, of Dundee, made a series of experiments to determine the relative frictional resistances of ropes and belts upon the pulleys over which they were run. The angle of the V of the groove in the rope pulley was made 40°, and both ropes and belts embraced one-half the circumference of their respective pulleys. The weight suspended from one end was 335.5 lbs. Taking an average of the experiments with ropes on dry pulleys, the coefficient of friction was found to be .90, while the average of the experiments with belts gave .68, a difference of .22 in favor of ropes, or 25 per cent. Some of these experiments—and they were those that gave the best results—were made with new ropes. In fact, the pulley remaining the same, we see that as the diameter of the cable diminishes it drops lower down into the groove, and the coefficient increases. The same thing occurs when the rope is at work and is subjected to varying strains: its diameter increases and diminishes in proportion to the strains that are put upon it, and consequently with the power that it is called upon to transmit.

This is an exceedingly important point, and shows how rational the system is.



Photographed by W. H. Rau, Philadelphia, Pa.

THE AMERICAN LINE STEAMER "ST. PAUL,"

MOVING DOWN THE DELAWARE RIVER ON THE WAY TO THE TRIAL TRIP.

In the experiments made with oiled pulleys, a considerable loss was made manifest.

The author then takes up the subject of the installation of rope drives, the arrangement of the framing, and gives a mathematical analysis of the work to be done, concluding with a report made by a committee appointed by the Industrial Society of the North of France. The conclusions of this committee were that, as a result of their investigations, it became evident that both ropes and belting afforded an excellent means for the transmission of power, provided that they were well designed and carefully erected. Rope transmission, however, because of the divisibility of the lines, which permits a multiple connection with the driving pulley; because of the elasticity of these lines, which are thus rendered capable of absorbing the variations of speed and power, both driving and resisting power; because of the high coefficient of friction, which allows the slack side to run very loose; and, finally, because of the low first cost—rope transmission, then, seems preferable to the use of belting. These advantages would in all cases warrant their successful application to industrial purposes.

It is very true that belts will render services equally valuable; but their high price and the requirements involved in their location are not elements that will tend to make them as popular as ropes of hemp and of cotton.

The final victory, when all builders shall be equipped, will undoubtedly belong to cables, at least until the transmission by electricity shall have been rendered more economical and practical than it is to-day—a time that may come, and in coming will place all competitors upon the same level by establishing itself in their places; but that is the secret of the future.

WATER TUBE BOILERS FOR WAR-SHIPS.

Some months ago we published very full abstracts of a discussion in Parliament and subsequent correspondence, with reference to the advisability of adopting water-tube boilers for the large new ships of the British Navy, which had been decided upon by the Admiralty. A recent number of *Engineering* contains a long letter from Mr. James Howden, of Glasgow, in which he opposes every strongly the use of such boilers. The letter is very interesting, but unfortunately we have not room for all of it, and therefore can give only a brief abstract of its most important points.

Mr. Howden says, first, that at the conclusion of the debate in Parliament it was understood that no more water-tube boilers should be ordered for the navy until their superiority over cylindrical boilers had been proved. This understanding, he says, does not appear to have been accepted by the Admiralty, as they have recently ordered engines and boilers for the new cruisers, the latter to be of the Belleville type. He now says that the Admiralty have no proof of the superiority of such boilers over those of the cylindrical type, and that the evidence which is obtainable shows their great inferiority.

He then quotes the trials of the *Sharpshooter*, which has water-tube boilers, and which were made at such a low power per unit of grate and heating surface as to be of no value as a test. Even at this low rate the consumption of coal was 1.8 lbs. to under 2 lbs. of coal per I.H.P. per hour.

In the trial of the two steamers, *Tamise* (with Belleville boilers) and *Seaford* (with cylindrical boilers)—two Newhaven and Dieppe steamers—the Belleville boilers consumed 37 tons of coal during the same period that the cylindrical boilers consumed 27. Since starting, the Belleville boilers, it is asserted, have required constant repairs, while during a year's running those in the *Seaford* required none up to the time she was lost.

The experience of Messrs. Thomas Wilson, Sons & Co., of Hull, is also quoted. They are the owners of the steamship *Ohio*, which has Belleville boilers, and is engaged in the trade between Hull and New York. "After being fully tried she left Hull on her first voyage. Before the vessel had cleared the south of Ireland, one of the boiler tubes burst and severely injured a fireman. The voyage to New York was made with considerable difficulty, owing to troubles arising in working the boilers, two at least being under repair during the voyage, which lasted 21 days, the average speed being under 7 knots."

While in New York her boilers were repaired, but her return voyage was a slow one. On returning from her second voyage to New York she was obliged to anchor in Dover Roads with boiler tubes leaking, the vessel having been 18 days out. A tug was sent from Hull as a convoy. Since the *Ohio's* trial her owners have ordered a large new steamer with cylindrical boilers.

The steamship *Unique*, on the lakes in this country, was also referred to. She was equipped with Babcock & Wilcox boilers, a 3-in. water-tube of which burst last May and killed two firemen, and blew the chief engineer, who was drowned, overboard.

Continuing, Mr. Howden says: "Whenever full power is attempted to be taken from water-tube boilers, the expenditure of coal becomes abnormal, tubes burst, and other serious damages arise, as has been shown in the case of the *Ohio* even when worked at low power continuously. Besides being at all times wasteful in fuel, the feed-water supply is always difficult to regulate. These defects, as I have said, are inherent in every water-tube boiler, *and cannot be got rid of by any modification of design.*"

The writer of the letter says, further: "These vital objections, in themselves more than sufficient to prevent further use of such boilers in sea-going ships, are: 1. The much greater consumption of coal they require per unit of power compared with cylindrical boilers. 2. The greater number of stokers they require for a given power."

In conclusion he says: "If their adoption (in the British Navy) is persisted in, disaster must inevitably occur should these ships ever be so unfortunate as to engage in actual warfare, while they will be a source of continual trouble and enormous expense whenever used for cruising purposes at any effective speed. Further, such boilers will permanently cripple, as has been clearly proven, every ship into which they are fitted, independently of their other vital defects, by greatly reducing their coal endurance at their lowest speed, much more at their highest, and by requiring many more men to work them. They will likewise never be able to maintain a high continuous speed."

This abstract of Mr. Howden's letter is given because it is intended to give both sides of this important discussion. Probably the portion of his letter which is most open to criticism is the part which we have italicised. To establish that statement he will be obliged to prove a negative, which the logicians tell us is impossible. The letter, though, is an interesting contribution to the discussion, and is certain to call out reply.

THE STEAMSHIP "ST. PAUL."

In our issue for July we published an illustrated description of the American Line steamer *St. Louis* that was built by the William Cramp & Sons Ship & Engine Building Company, of Philadelphia. The sister ship, the *St. Paul*, has now been completed in accordance with the agreement with the Government made at the time when the *Paris* and *New York* were admitted to an American register. The two vessels are alike in all particulars, with the exception of a few minor details, changes in which have been made since the *St. Louis* went into commission, and which were suggested by the experience with that ship. To the casual observer the only noticeable difference between the two is in the smoke-stacks, where the cowls used on the *St. Louis* do not appear on the *St. Paul*. For a description of the steamers we would refer our readers to the one published of the *St. Louis* in our issue for July.

The engravings of the *St. Paul* on the opposite page are reproductions of photographs taken as the vessel was slowly steaming down the Delaware River on her way to the official trial off the coast of Massachusetts. The object of this trial was to comply with the terms of the agreement with the Government, by which a contract for carrying the United States mails is awarded, provided that the vessel maintain an average speed of 20 knots on a run at sea of four hours' duration. In the trial of the *St. Louis*, which was held in the English Channel, in August, the average speed was 22 2 knots. As the bottom of the *St. Paul* was foul at the time of the trial, she did not equal the speed of the *St. Louis*. The trial run was made between Cape Ann, Mass., and Cape Porpoise, Me., a distance of 41.96 nautical miles, at an average speed of 20½ knots. The engines worked as smoothly and as easily as though they had been running for months The run was over the course, a turn and a return over the same. On the eastward run the average number of revolutions of the screws was 89.5, and about 90 on the westward.

Immediately after the trial the vessel was taken to New York and placed in service on the line, sailing on her maiden voyage for Southampton on October 9. There was nothing noteworthy about the trip, the time from Sandy Hook Lightship to the Needles being 7 days, 12 hours, and 20 minutes, with daily runs of 394 382, 409, 412, 439, 324, 399, and 319 miles. Like the *St. Louis*, she is proving a splendid sea boat.

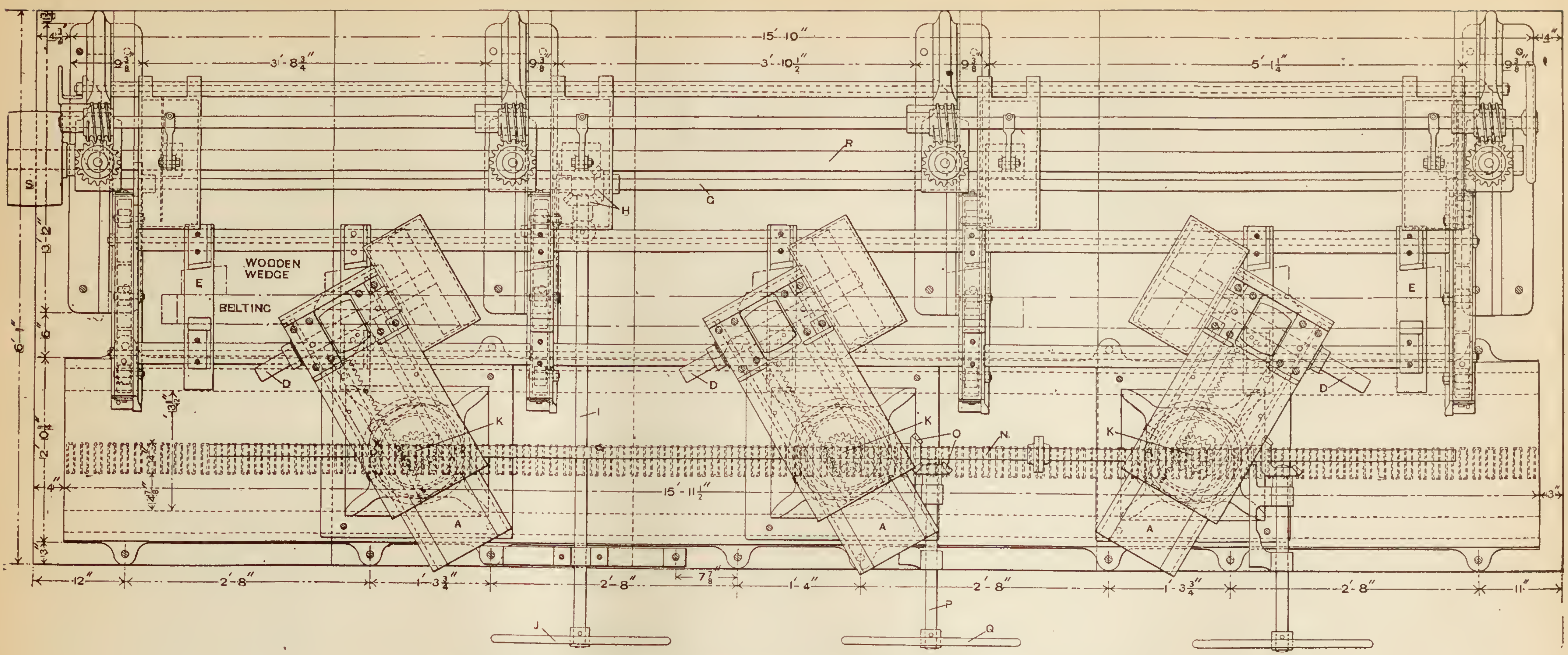


Fig. 1.—PLAN OF BELT-RAIL CHECKING MACHINE, GRAND TRUNK RAILWAY SHOPS.

BELT-RAIL CHECKING MACHINE, GRAND TRUNK RAILWAY.

In our last issue we illustrated the standard box car of the Grand Trunk Railway, and in the course of the description alluded to a belt rail checking machine on which the checking or gaining of the belt rails for the passage of the posts and braces is done. Through the courtesy of the officials we are now enabled to present engravings showing the construction of the machine.

There are seven cutter-heads, two of which also carry cutting-off saws for cutting the rails to the proper length. Of these three are for the diagonal gaining, are mounted on separate shafts and can be set at any angle, while the others are mounted upon a single shaft, and are for cutting gains that run at right angles to the length of the rail. For the sake of clearness as to the actual work done by the machine we illustrate a belt-rail showing in detail the work that is done.

The heads that do the diagonal checking are mounted on the carriages *A A A* that are pivoted upon the standards *B B B*, and can be set at any desired angle, according to the work that is to be done. The standards *B B B* can be adjusted longitudinally by sliding them over the base-plate to which they are held and clamped in position by means of the T-bolts, as shown in the end elevation (fig. 3). The diagonal cutters are mounted upon the shafts *D D D*, which are driven by the belts *C C C* from overhead drums. When these cutters and carriages are in position the belt-rail is clamped to the heads *E E E E*, as shown on the side elevation (fig. 2), and the plan (fig. 1). These heads can be run forward and back by means of the gears *F* that are placed at the ends of the shaft *G*, and which mesh in with the rack on the bottom of the carriage, as seen in the end elevation. The heads and with them the belt-rail are operated by means of the hand-wheel *J*, the shaft *I*, the mitre gears *H H*, and the shaft *G*.

When the diagonal gains are cut the belt-rail is run forward to the extreme front end of the travel of its holding-heads, and the diagonal cutters run across it. These are worked simultaneously by means of the hand-wheel *Q*, the shaft *P*, the mitre gears *O*, the shaft *N* (fig. 1), the mitre gears *M* (fig. 3), and the vertical shaft carrying the pinions *K K K* that mesh in with the racks on the pivoted carriages, and thus move the cutters in and out regardless of the angle at which the heads may be set.

After the diagonal gains are cut the rail is run back, as already stated, for the cutting of the straight gains.

The cutters *T T T T* doing this portion of the work are mounted upon the shaft *R*, which is driven by a belt running over the pulley *S* at one end. These cutter-heads are susceptible of longitudinal adjustment individually, while the whole shaft can be raised and lowered, as will be presently explained. The two cutters at the ends are bolted to cross-cut saws that are adjusted to cut the rails off to the proper lengths.

Thus the work of checking these belt-rails consists in first clamping them to the heads and running these latter into the forward position ; then by means of the hand-wheel *Q* the

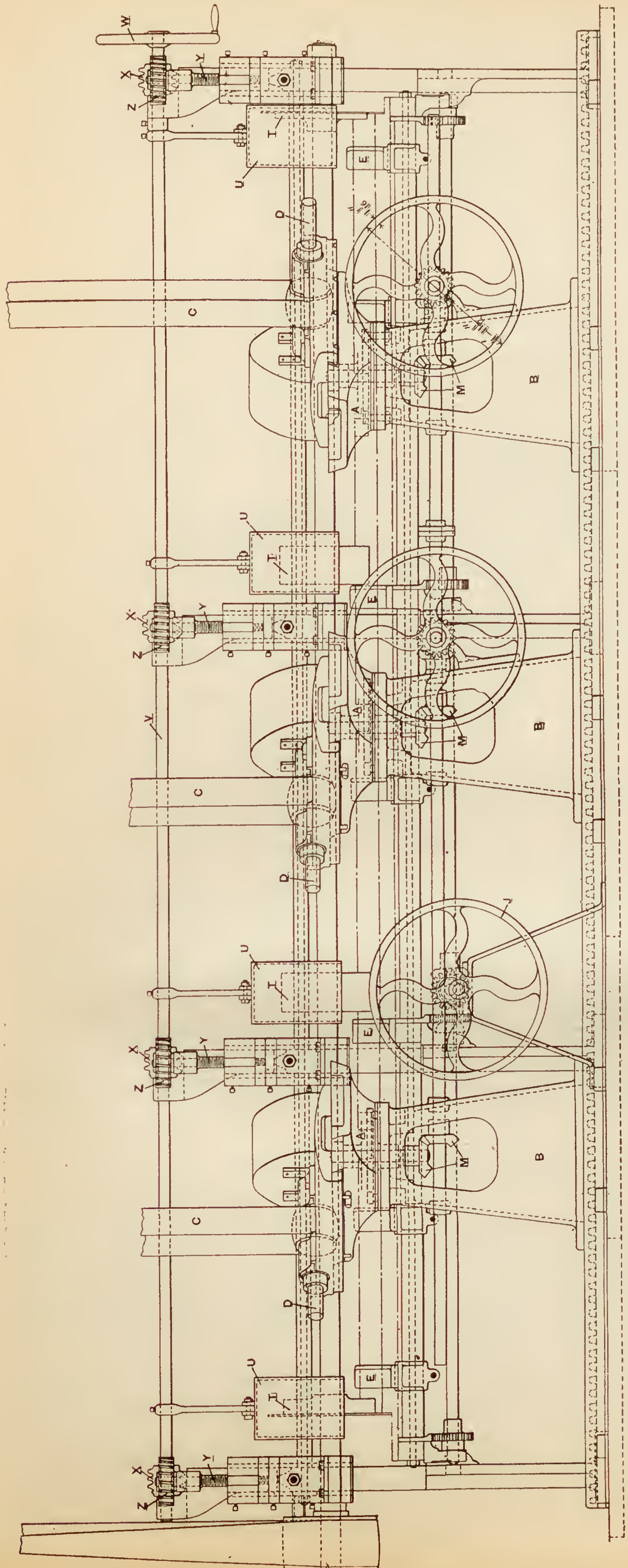


FIG. 2.—SIDE ELEVATION OF BELT-RAIL CHECKING MACHINE, GRAND TRUNK RAILWAY SHOPS.

cutters are run out and the diagonal gains cut. After they are withdrawn the belt-rail is run back beneath the straight cutters on the shaft *S* by means of the hand-wheel *J*, and there they are cut to length and the straight gains cut.

All of the cutters are protected by hoods that catch the shavings and prevent careless workmen from getting their hands mutilated by the revolving knives. The hoods *U U U U* covering the straight cutters are suspended from the shaft *V*.

The shaft *R* is raised and lowered for the adjustment of the cutters *T T T T* by means of the hand-wheel *W*, located at one end of the machine, as shown in fig. 2, and keyed to the shaft *V*. On this shaft there are four worms *X X X X* that mesh with the gears *Z Z Z Z* keyed to the vertical shafts *Y Y Y Y*, that are cut with a screw and run in nuts in the carriages that contain the bearings of the shaft *R*. These carriages will be seen from fig. 2 to be fitted to work in guides on the main bed-plate.

It will be seen from the foregoing description that the machine is adjustable in all of its working parts to meet the requirements of any piece of work that may be brought to it, provided, of course, that its size does not exceed the limits of the machine. For the special work for which it was designed, it has reduced the labor of checking to a minimum, the whole being done with two operations and without disturbing the piece from its fastenings. The machine was designed and built at the Grand Trunk shops in Montreal, because large quantities of these pieces were wanted in duplicate and there was nothing upon the market that had a capacity sufficient to meet the requirements of the case.

AMONG THE SHOPS.

H. K. PORTER & CO., OF PITTSBURGH.

It will be no news to our readers if we remark that the past two have been years of depression in locomotive building, and the proprietors have usually had ample time to plan and execute improvements in plant and design in anticipation of the better times that we all hope are now opening before us. Among the manufacturers who have done this is the firm of H. P. Porter & Co., of Pittsburgh, who have put up new buildings and installed new tools with the double purpose in view of increasing the possible output and decreasing the cost of the same. In order to attain the latter object the milling machine has been liberally used. It is somewhat startling to learn what is being actually accomplished with these machines in comparison with that previously done on the planer. For example, it formerly required all of the time of four planers to do the work of the establishment on driving-boxes and wedges; now two milling machines attended by one man do it all in less than half the time. The rough castings are put in and finished at a single cut on Pratt & Whitney machines, and finished with an accuracy that would not be commercially practicable on a planer. In order to do this with the greatest economy and accuracy, the castings are first pickled, to remove all scale and sand, and especial attention is paid to getting a fine-grained, easily worked metal. Another example of the great advance that milling is over planing is afforded in the work done upon a certain class of cross-head, where, upon a planer, from seven to eight hours were required, and now upon the miller the cross heads are finished at a single cut in 30 minutes, or, including the setting, 40 minutes. These are exceptional results, and are somewhat better than any we have heretofore met with, though it is usually acknowledged that

the milling machine is from three to four times as rapid a worker as the planer.

Of course, to secure the best results with the milling machine it is desirable that a great deal of work should be done in duplicate, and that especial attachments should be provided for holding and setting the same. This feature has received the especial attention of Mr. Lord, the Superintendent of the works, and there are cutters and chucks to do each piece of work that presents itself. A further advantage of providing these special appliances is found in the fact that the rigid holding of the work can be depended upon with so much certainty that the feed can be *with* the motion of the cutter instead of *against* it, without any fear of it becoming loose and being drawn in with the disastrous results to the machine or cutter or both that is sure to follow such an accident, as many know to their sorrow. The advantage of a feed with the cutter is that the strain on the gear is less, being the difference between the pull of the cutter and the friction of the parts rather than the sum of the thrust of the cutter and the friction of the parts. That this feed is safe is evidenced by the fact that on one Pratt & Whitney machine a gang chuck holds a number of rod brasses that are milled complete on the two sides and as smoothly as though they were burnished on a feed of 8 in. per minute that is never allowed to drop below 6 in. and has been raised to 9 in.

There is, however, another side to this milling question that must be considered in estimating upon the saving to be effected by them, and that is the duplicating of parts, as we have already suggested. This is one of the advantages of the shops of H. K. Porter & Co. They manufacture small locomotives; they manufacture them for the most part in stock sizes, and they keep a complete set of duplicate parts of all sizes on hand, so that it frequently happens that the filling of an order merely requires that the needed parts, such as frames, rods, and valve gear complete, be taken from stock and assembled. This necessitates absolute interchangeability of parts that can best be obtained by milling. It is of very great commercial value to a firm to be able to make prompt deliveries of extra parts

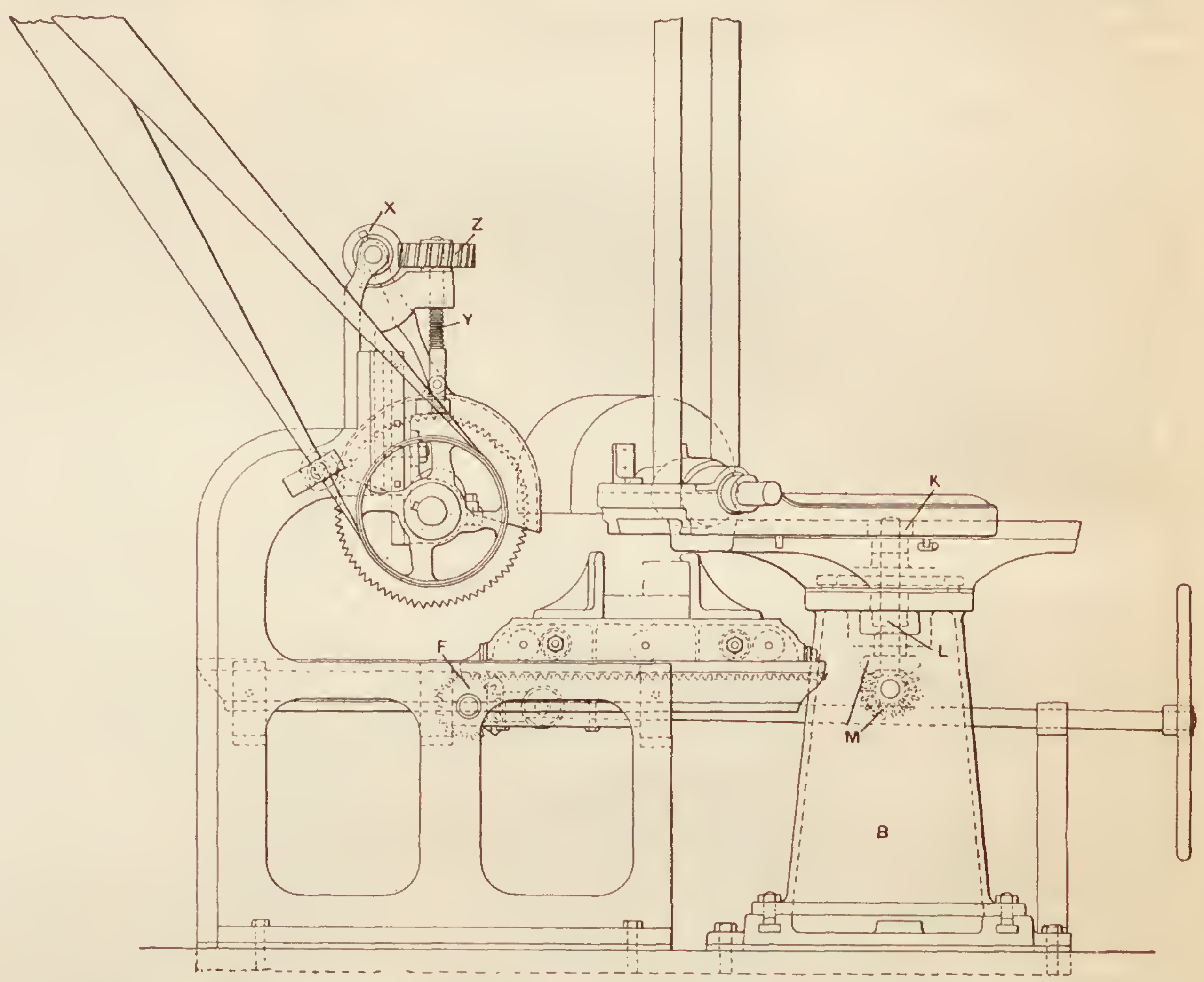


Fig. 3.—END ELEVATION OF BELT-RAIL CHECKING MACHINE, GRAND TRUNK RAILWAY SHOPS.

Of course, every shop has its own peculiar practices; and among those current here is the use of cast-iron rocker arms. They are universally used upon all engines, and there is no trouble about breakage. Whether the same could be made to be true of large and heavy locomotives is open to discussion. These rockers are turned over the bearings and on the bosses and are then ground to a finish. Some of us who are not so very old can recollect the time when the milling machine began to supersede the slotter for finishing the irregular faces at the hubs and ends of rocker arms. Now, after the milling machine has driven the planer and the shaper from fields that were formerly their own, it is compelled to retire before the plain, common, every-day grindstone. Of course it is not accuracy but beauty of finish that the grindstone gives, but it gives what is wanted, and no more is asked. This grinding is applied to a large variety of objects where polish and not accuracy is desired, even where as much as $\frac{1}{4}$ in. of metal is to be removed.

Cast iron is also extensively used for the smaller sizes of

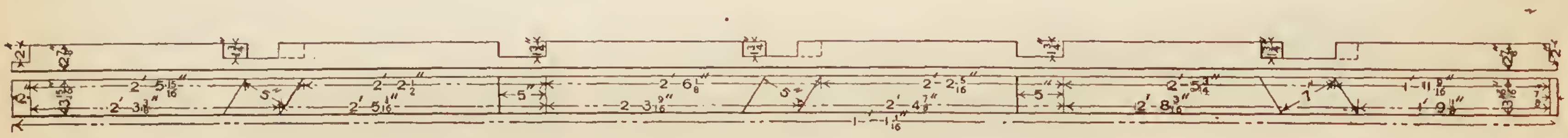


Fig. 4.—BELT-RAIL SHOWING CHECKING, GRAND TRUNK RAILWAY STANDARD BOX CAR.

for repairs, especially where the customers are the owners of only one or two locomotives, and to whom a break down means the stoppage of all work until repairs are made. A case in point may be cited where repair parts, including boiler, rods, and a number of other pieces, were ordered for an engine in Brazil, and the steamer was to sail in a week. Everything was ready, was taken from stock, shipped at once, caught the steamer, much to the satisfaction of the buyer.

Another tool that is serving as a great saver is a turret machine. It simply does the work of five lathes. It is hardly necessary to enlarge upon this brief statement except that, besides enabling one man to do the work of five in the machine shop, it has taken some work out of the blacksmith shop. When all work was done on the lathe, pins with heads or collars were forged to save turning; now they are cut off from the bar that is fed into the machine, as the turret will cut off surplus metal for less money than the blacksmith can draw it out.

driving-wheels, and in others where steel tires are used the latter are pressed and riveted on instead of shrinking. This is done in mining locomotives, where they are frequently sent down a shaft 500 ft. or more in depth and never come to the surface again until they are scrap. Under these circumstances the replacing of a tire by shrinking would be difficult, if not dangerous, whereas the pressed-on tire can be easily removed, a couple of jacks can put on the new one, and the rivets hold it fast.

We cannot close this brief account of the special features of these shops without referring to the great strength that is put into these small locomotives. On comparing the sizes and thicknesses of metal used, and the bracing of all parts with similar parts in locomotives intended for heavy service on trunk lines, the first impression is apt to be that one is uselessly heavy or the other ridiculously weak. But when we consider that these locomotives are almost invariably put to the hardest sort of service—that they must run over the rough, temporary track of

the contractor, over the cinder heaps and amid the flying dust of steel works and furnaces, or do switching work of the severest kind, like that of the New York & Brooklyn Bridge locomotive illustrated in our last issue; that they are run by all sorts and conditions of men, to whom to apply the name of engineers would be the grossest flattery; that they are banged hither and yon; that they are used to make couplings with the violence of a young collision, and that they have no friends, we can readily understand that this field of locomotive engineering is one that needs careful consideration, and the reason for the large sizes of metal, heavy castings, and rigid bracing becomes apparent. In fact, the output of the shops and the results obtained with it show that this careful study has been made.

THE PITTSBURGH LOCOMOTIVE WORKS.

For several years the shops of the Pittsburgh Locomotive Works have been passing through a series of changes which have finally developed one of the finest and best-arranged locomotive plants in the country. The work of demolition and rebuilding has been carried on without any interruption to the current business of the establishment, and yet in accordance with a prearranged plan that has resulted in the complete establishment, or perhaps we should say "will result," as the changes have not all been effected as yet.

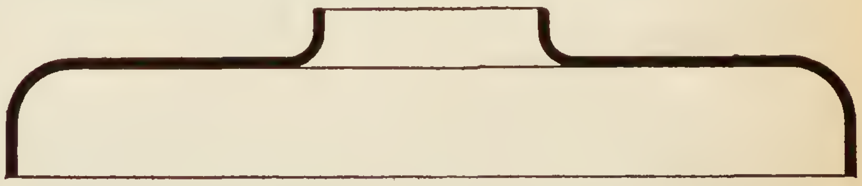
The arrangement of the machine shop has been the subject of so many discussions, and has received so much attention from men interested in economical production, that one type seems to have been generally accepted as best adapted for locomotive and other heavy work. This is the long shop with side bays, in which the smaller tools are placed, while the central space is spanned by a travelling crane having a capacity commensurate with the work to be done, and serving the tools intended for the heavier classes of work. This is the plan adopted at Pittsburgh. This and the other new shops are of brick with iron roofs, and is remarkably well lighted. The windows are in all cases very wide, and the walls between narrow, the ratio of three to one being about the average. Winding in and out among the shops, running to all of the heavier machines, and penetrating every place where material is stored or used, is a system of tracks of 2 ft. gauge, upon which there is a locomotive for doing the hauling. Of coursg these tracks are supplemented by others of the standard gauge leading into the works for the delivery and shipment of materials, but for movements made between different parts of the works the narrow-gauge tracks are used.

The power-house is centrally located, and steam is supplied by ten vertical boilers, that are at present fired with natural gas, though provision is made for firing with coal. These boilers have some peculiarities of construction that render them particularly accessible in all of their parts, and illustrations of which will appear in a future issue. One of them is designed to carry a pressure of 250 lbs. per square inch, and will be used for supplying a pressure for the testing of locomotive boilers. In this power-house, which is not yet entirely completed, is to be located the machinery for driving the entire plant. It is centrally located, and the shafting is to be led off to the several shops. The foundry is one of the finest buildings on the premises, and is equipped with machinery of the latest design. There are three cupolas, the usual complement of cranes and moulding machines. One feature is especially attractive, and that is a depressed core room. The large oven and flues, as they are usually arranged, renders it necessary to block out all the light from one side and most of that coming in from the roof, so that there are always dark places in the core room, where waste material congregates and a litter is sure to prevail. Here the core floor is depressed below that of the foundry floor, so that the tops of the core ovens are on a level with the latter. This leaves the side walls free for the location of the windows and floods the floor with light from above.

At the other end of the shop there are located the moulding machines, which are of both the mechanical and pneumatic type. It has been the prevailing impression that machine moulding was only adapted to simple forms that were to be reproduced in large quantities, but experience has shown that this is not necessarily the case. Of course, metal patterns are the thing for pieces like brake shoes and the like, both on account of the greater durability and ease of manipulation, but wooden patterns of the ordinary type can be employed profitably and with ease. On a double pneumatic machine, like one in use in these shops, for example, two sets of wooden patterns are kept in service, though they need not necessarily be duplicates of each other. One set or one set of halves is placed on a follow board that has holes in it to take the dowel pins or pins to engage in the holes, and they are rammed by the pressure applied. The table swings out of the way, two laborers carry the drag, let us say, to the floor, where a moulder draws the pattern and slicks up the mould; meanwhile, the other halves are placed on their follow board and rammed for the cope, which is carried away, and the first set of halves returned to the machine. The operation is very rapid, hardly occupying more time than it takes to tell of it; and one moulder can keep pace with the machine. It must be borne in mind, in this connection, that, owing to the evenness of the ramming, very little dressing is needed for the moulds and almost no blacking is used, so that the long slow process that accompanies hand labor is entirely done away with and the cost of the castings correspondingly lessened. Of course, where large quantities of any one casting are wanted, stripping plates and the drawing of the pattern by the machine is desirable; but where only a few are desired, machine ramming and hand drawing will be found to be possible and economical.

The show place of this establishment is undoubtedly the forge shop. It is the lightest and airiest place of the kind of which we have any knowledge. The furnaces are fired by natural gas, steam is supplied by vertical boilers similar to those used in the power-house, the forges are well hooded, and the roof is so high and the stacks have such a good natural draft that no smoke or gas escapes into the room except when heavy fires are being made. The room impresses one as being an exhibition, with everything arranged to produce the best possible effect. The machinery is of the type that is usually found in such a place, and every possible facility is offered for the handling of material.

In the boiler shop hydraulic flanging and power riveting prevails. Some of the flanging is done with remarkable skill and shows what fine work can be done with skilful handling even on the lower grades of steel. Tank steel, for example, is used for dome casings and sand-box covers, and even where it has to be drawn as in the accompanying sketch, there is no sign of any tearing or cracking of the metal, while the part subjected to compression is entirely free from crimps. The boiler flanging is done on a press similar to that in use in the



DOME CASING PRESSED FROM TANK IRON, PITTSBURGH LOCOMOTIVE WORKS.

Juniata shops of the Pennsylvania Railroad, to which a reference was made in our issue for June, and embraces all of the flanging for the boiler. While it would probably be impossible for any locomotive shops to have a wide range of distinctive features in the tools with which the work is done, it is shown here that a careful study of the best current practice and the adaptation of that practice to the individual case in hand can be made to produce a shop that possesses the very distinctive and desirable feature of adaptation to the requirements of economical production with the added quality of plenty of light, air, and elbow room, which may and possibly ought to be considered a function of this same economical production.

PROCEEDINGS OF SOCIETIES.

Master Car-Builders' Association.—The Thirtieth Annual Convention of the Association will be held at Saratoga, N. Y., commencing on Wednesday, June 17, 1896, which is one week later than the date prescribed by the by-laws. This change is made after consultation with the Executive Committee of the American Railway Master Mechanics' Association and the unanimous vote of the Executive Committees of both associations in favor thereof. Headquarters will be at Congress Hall, which has made the following terms: Single rooms, $3 per day; double rooms, one person, $4 per day; double rooms, two persons (each) $3 per day. These rates are for members of the Association and their friends. Members of the Association will have preference of rooms until March 1, 1896. Application for rooms should be made to H. S. Clement, Manager, Congress Hall, Saratoga, N. Y., and the Committee of Arrangements requests that members should apply at once for rooms, as those who first apply will be best served.

Engineers' Club of St. Louis.—At the meeting of October 2 Mr. Richard McCulloch read a paper on "The Continuous Rail in Street Railway Service." He described briefly the work done in St. Louis and elsewhere, and the processes em-

ployed. The paper was illustrated by drawings, photographs, rail sections, and samples of joints. Two systems had been employed in St. Louis, electric welding and cast welding. The latter, requiring a less expensive plant, being simpler and easier to operate, and the work appearing to stand service better, had been given the preference. In spite of the extreme temperatures, but a very small percentage of the joints had broken, and these were clearly due to defective welds. The cost was not greatly in excess of the old fishplate method. It was thought that the rail, being surrounded by earth or paving on all sides except the top, it was protected from the extreme variations of temperature, and being held rigidly in position, these two features tended to counteract the expansion and contraction which would ordinarily be expected.

New York Railroad Club.—At the meeting of October 17 Mr. E. E. Russell Trotman read a paper upon "Painted *versus* Planished Iron Boiler Jackets." The data given was very complete, and was obtained from a number of leading trunk lines that have adopted or are using the painted jackets. The conclusions reached from the reports received are that the painted jacket is the superior of the two. It is heavier, and therefore not so liable to be indented or injured by the engine crew; it is less liable to corrode through the action of drippings from roundhouse roofs falling upon it; it requires less labor and attention to keep it clean; it maintains a good appearance longer than the planished iron, and a fresh coat of paint will make it look as good as new, and it may be applied for a very much lower cost than the planished iron, it being reported on one road to cost $17 less than the old style. This, however, is a point in which the personal factor enters, as it depends upon the taste and judgment of the officials as to the elaborateness with which the painting shall be done; this item amounting, in some cases, to so much as to make the painted jacket more expensive than the planished iron, though it is generally conceded that this is unnecessary, both on the score of appearance and economy, for a single coat of Roger's locomotive black is all that is required, and this can be applied for less than $3.

After the reading and discussion of the paper, there was a topical discussion on large box cars, in which the railroads seemed to be opposed to the increase in the size of cars from the standpoint of both economy of operation and revenue derived from them. It was, however, considered of enough importance to warrant the appointment of a committee to report upon the same, which consists of Messrs. Wheatley, Fowler, and Moore.

American International Association of Railway Superintendents of Bridges and Buildings.—At the meeting held at New Orleans, La., on October 16 a report was presented by a committee of which Mr. Walter G. Berg was chairman, on the "Strength of Bridge and Trestle Timbers." It was stated that the wide range of values for the working strengths of timbers by the various recognized authorities is probably due to the unwarranted importance attributed by them in their deductions to isolated tests of small-sized specimens, that were not only limited in number, but which were especially defective in that no data was noted and recorded regarding the exact species of the specimen tested, as well as its origin, condition, quality, the degree of seasoning, the method of testing, etc.

The fact has been proved beyond dispute that small-size specimen tests give much larger average results than full-size tests, owing to the greater freedom of small selected test pieces from blemishes and imperfections, and their being, as a rule, comparatively drier and better seasoned than full-size sticks. The exact increase, as shown by tests and by statements of different authorities, is from 10 to over 100 per cent.

Recently, however, elaborate tests have been made on full-size specimens, and from the data thus obtained the general correctness of the following conclusions is believed to be established:

1. Of all structural materials used for bridges and trestles, timber is the most variable as to the properties and strength of different pieces classed as belonging to the same species, hence impossible to establish close and reliable limits of strength for each species.

2. The various names applied to one and the same species in different parts of the country lead to great confusion in classifying or applying results of tests.

3. Variations in strength are generally directly proportional to the density or weight of timber.

4. As a rule, a reduction of moisture is accompanied by an increase in strength; in other words, seasoned lumber is stronger than green lumber.

5. Structures should be, in general, designed for the strength of green or moderately seasoned lumber of average quality, and not for a high grade of well-seasoned material.

6. Age or use do not destroy the strength of timber, unless decay or season checking takes place.

7. Timber, unlike materials of a more homogeneous nature, as iron and steel, has no well-defined limit of elasticity. As a rule, it can be strained very near to the breaking point without serious injury, which accounts for the continuous use of many timber structures with the material strained far beyond the usually accepted safe limits. On the other hand, sudden and frequently inexplicable failures of individual sticks at very low limits are liable to occur.

8. Knots, even when sound and tight, are one of the most objectionable features of timber, both for beams and struts. The full-size tests of every experimenter have demonstrated, not only that beams break at knots, but that invariably timber struts will fail at a knot, or owing to the proximity of a knot, by reducing the effective area of the stick and causing curly and cross-grained fibres, thus exploding the old practical view that sound and tight knots are not detrimental to timber in compression.

9. Excepting in top logs of a tree or very small and young timber, the heart-wood is, as a rule, not as strong as the material farther away from the heart. This becomes more generally apparent, in practice, in large sticks with considerable heart-wood cut from old trees in which the heart has begun to decay or been wind-shaken. Beams cut from such material frequently season-check along the middle of beam and fail by longitudinal shearing.

10. Top logs are not as strong as butt-logs, provided the latter have sound timber.

11. The results of compression tests are more uniform and vary less for one species of timber than any other kind of test; hence, if only one kind of test can be made, it would seem that a compressive test will furnish the most reliable comparative results.

12. Long timber columns generally fail by lateral deflection or "buckling" when the length exceeds the least cross-sectional dimension of the stick by 20; in other words, the column is longer than 20 diameters. In practice the unit stress for all columns over 15 diameters should be reduced in accordance with the various rules and formulæ established for long columns.

13. Uneven end-bearings and eccentric loading of columns produce more serious disturbances than usually assumed.

14. The tests of full-size long compound columns, composed of several sticks bolted and fastened together at intervals, show essentially the same ultimate unit resistance for the compound column as each component stick would have if considered as a column by itself.

15. More attention should be given in practice to the proper proportioning of bearing areas; in other words, the compressive bearing resistance of timber with and across grain, especially the latter, owing to the tendency of an excessive crushing stress across grain to indent the timber, thereby destroying the fibre and increasing the liability to speedy decay, especially when exposed to the weather and the continual working produced by moving loads.

In addition to the ultimate breaking unit stress, the designer of a timber structure has to establish the safe allowable unit stress for the species of timber to be used. This will vary for each particular class of structures and individual conditions. The selection of the proper "factor of safety" is largely a question of personal judgment and experience, and offers the best opportunity for the display of analytical and practical ability on the part of the designer. It is difficult to give specific rules. The following are some of the controlling questions to be considered:

The class of structure, whether temporary or permanent, and the nature of the loading, whether dead or live. If live, then whether the application of the load is accompanied by severe dynamic shocks and pounding of the structure. Whether the assumed loading for calculations is the absolute maximum rarely to be applied in practice, or a possibility that may frequently take place. Prolonged heavy steady loading and also alternate tensile and compressive stresses in the same piece will call for lower averages. Information as to whether the assumed breaking stresses are based on full-size or small-size tests or only on interpolated values, averaged from tests of similar species of timber, is valuable in order to attribute the proper degree of importance to recommended average values. The class of timber to be used, and its condition and quality. Finally, the particular kind of strain the stick is to be subjected to, and its position in the structure with regard to its importance and the possible damage that might be caused by its failure.

In order to present something definite on this subject, the committee presented a table showing the average safe allowable working unit stresses for the principal bridge and trestle timbers, prepared to meet the average conditions existing in railroad timber structures, the units being based upon the ultimate breaking unit stresses recommended by the committee, and the following factors of safety—viz.:

Tension, with and across grain	10
Compression, with grain	5
" across grain	4
Transverse rupture, extreme fibre stress	6
" " modulus of elasticity	2
Shearing, with and across grain	4

In these tables these factors of safety are worked out to show the actual ultimate strengths of the various materials, as well as the safe loads to which they may be subjected.

OBITUARY.

Franklin Leonard Pope.

This well-known electrician was instantly killed on Sunday evening, October 13, in his own home at Great Barrington, Mass., by a current of electricity from a converter which was used in connection with the electric-light plant which supplied his house. He went into the cellar after the lights had been turned on to give some attention to this converter. His family upstairs heard a heavy fall, and on going down found him dead on the floor beside the converter.

Mr. Pope was one of the best-informed and practical electricians in this or perhaps any other country, and it is said that he is the first scientific man of prominence to meet his death in this way. Two physicians were summoned immediately after the accident, but their efforts to resuscitate him were of no avail. The exact manner or cause of his death is only a matter of surmise, but must have been due to some defect in the apparatus, as a person with his knowledge would have been incapable of making a fatal mistake.

He was born in the village of Great Barrington on December 2, 1840, and was educated in the local schools of that place, and afterward spent a year at the academy in Amherst, Mass

He early developed a taste and aptitude for science and mechanics, and it is said that the first money he earned was by making and selling water-color drawings of locomotives on the Housatonic Railroad.

For the following facts in relation to his life we are indebted to the *Electrical World*:

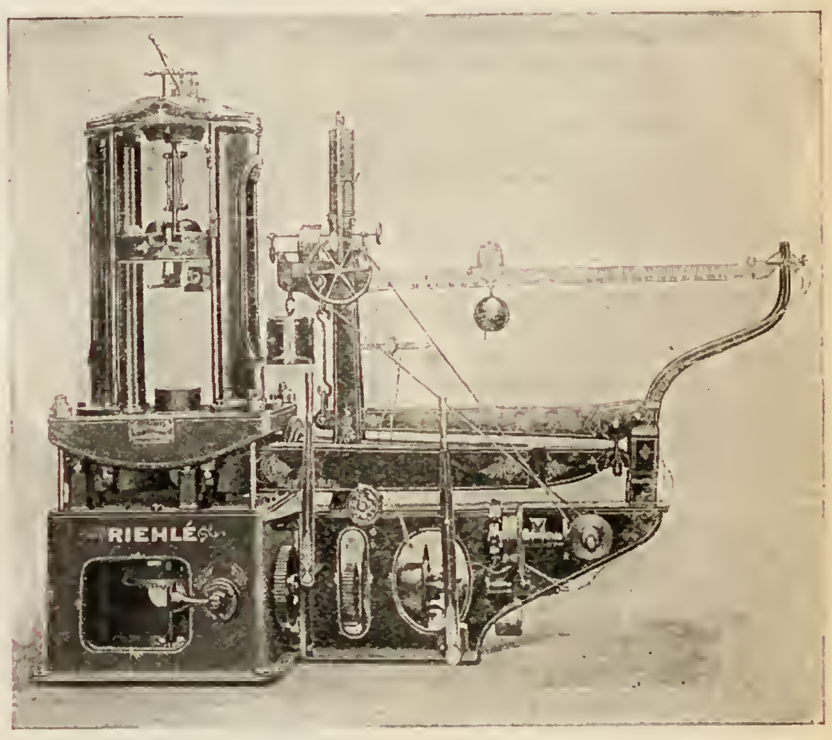
"In 1857 Mr. Pope was appointed operator at Great Barrington in charge of the office of the American Telegraph Company, having for the purpose received instruction in the operation of the Hughes printer. From this position he was transferred to Springfield, Mass., as circuit manager in charge of the line between there and Albany. Early in 1860 he went to New York and was engaged on the *Scientific American* as an artist and writer until after the outbreak of the Civil War, when he again entered the telegraph service as operator at Providence. He became at this time an expert Morse operator, and his unusual ability attracted the attention of General Marshall Lefferts, the Engineer-in-Chief of the American Telegraph Company, who soon transferred Mr. Pope to a more prominent position in the New York office, where he was engaged in the preparation of a series of maps of the whole system of telegraph lines owned by the company.

"During the draft riots in New York Mr. Pope met with many exciting adventures in his successful attempt to restore communication between New York and Boston, the lines in the city having been cut by the rioters. In 1864 he accepted the appointment as Assistant Engineer of the Russo-American telegraph, a projected line from Washington Territory to Siberia *via* Behring Straits, which was partly finished, but abandoned three years later. In this capacity he made an exploration and survey of the southern portion of Alaska in the watershed of the Stiskeen River, going overland in the winter with sledges and dogs from Lake Tatla, B. C. After his return from Alaska, Mr. Pope for some time edited the *Telegrapher*, and also wrote his well-known work, "The Modern Practice of the Electric Telegraph," which has ever since its publication been recognized as the standard authority on that subject. For the decade following his return to New York, he devoted himself to inventions, and in that time organized the gold and stock reporting system, using the Laws instrument; originated private line printing telegraphy, and invented a thoroughly practicable system of electric signals for steam railways, which has since been developed by the Union Switch & Signal Company. Mr. Pope was, in 1885, placed in charge of the patent interests of the Gold & Stock Telegraph Company, but soon accepted a similar position with the Western Union Telegraph Company, in which he remained until 1891, when he engaged in private practice as a patent solicitor and expert. In 1884 he assumed editorial charge of the monthly *Electrician*, the title of which was then changed to the *Electrician and Electrical Engineer*, which position he filled until the spring of 1890. Mr. Pope was a charter member of the American Institute of Electrical Engineers, and in 1886 was elected its second President. Throughout his active career Mr. Pope has given much attention to various historical investigations, and the very thorough manner in which he has brought to light the early work of Davenport, House, and other inventors, has led to the general recognition of the real merit of their labors in the electrical field."

He had been a voluminous writer on subjects relating to his specialty, and had a clear, forcible style that was very attractive to his readers. His extended experience and knowledge gave a practical cast to his writings which is very much lacking in a great deal of the electrical literature of the present day.

During the latter part of his life his services were much sought for in cases of patent litigation. One of the attorneys with whom he was often associated said, "he was a wonderful man, and not too much can be said in his praise; and it is a fact that the quality of his honesty was such that he was not an available witness, though he was the best-informed man in the country. He would insist on telling his ideas on the witness stand."

As a friend and companion he was charming. He had a naïve manner and speech and a kindly, original, and often humorous way of regarding what he observed that was extremely entertaining. Below it all there was a substratum of intellectual and moral integrity which secured the confidence of all who knew him. He leaves a widow, two daughters, a son, and a great many friends who will mourn his untimely death.



THE RIEHLE STANDARD AUTOMATIC TESTING MACHINE.

Manufactures.

RIEHLE UNITED STATES STANDARD AUTOMATIC TESTING MACHINE.

This is a very complete machine of moderate capacity, combining automatic weighing apparatus with variable speeds with the latest improved autographic recording device. This machine was first made for hand-power, and in using the automatic attachments belt-power was introduced for the purpose of communicating regular and steady movements to the working parts. A round belt from the counter-shaft drives

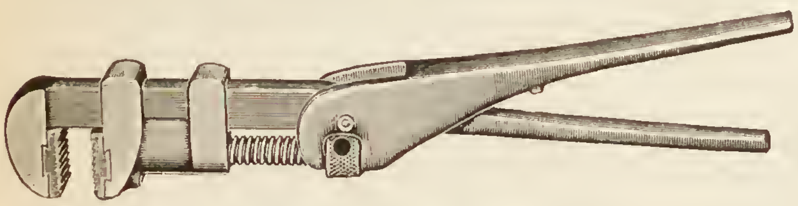
the disk of the weighing apparatus, while a second flat belt is used to transmit the power.

The motion of the poise is transmitted to the diagram by the screw and nut carrying a pencil in a vertical direction, while the stretch of the specimen is communicated by a multiplying extensometre to the vertical drum, causing it to revolve, thus forming a complete strain diagram.

This automatic machine is made in capacities from 20,000 lbs. up to 400,000 lbs. at the Riehle Brothers Testing Machine Company's works, Ninth Street above Master, Philadelphia.

THE WRIGHT WRENCH.

This wrench, which is made by the Wright Wrench Co. of Worcester, Mass., is an adaptation of the monkey-wrench type to the pipe-wrench, and it seems to have been done in a very practical and efficient way. The jaws are faced with toothed or smooth plates, that can be removed when worn, or taken out and replaced the one for the other. The head is moved by a screw and nut, the latter being placed in the enlarged portion of the movable handle, and has bar-holes in it, so that the jaws can be forcibly tightened against the work before



THE WRIGHT PIPE WRENCH.

there is any attempt at turning. The lever in which the nut is placed gives a very long purchase, and every effort to turn the pipe causes an increased tightening of the jaws, as will be seen from an examination of the construction. All parts of the wrench are made to gauge and are interchangeable, so that repair parts can be furnished at a small expense; this also facilitates the removal of the jaw-plates, which may be taken out and sharpened and then replaced, or the substitution of new ones when the old are worn out.

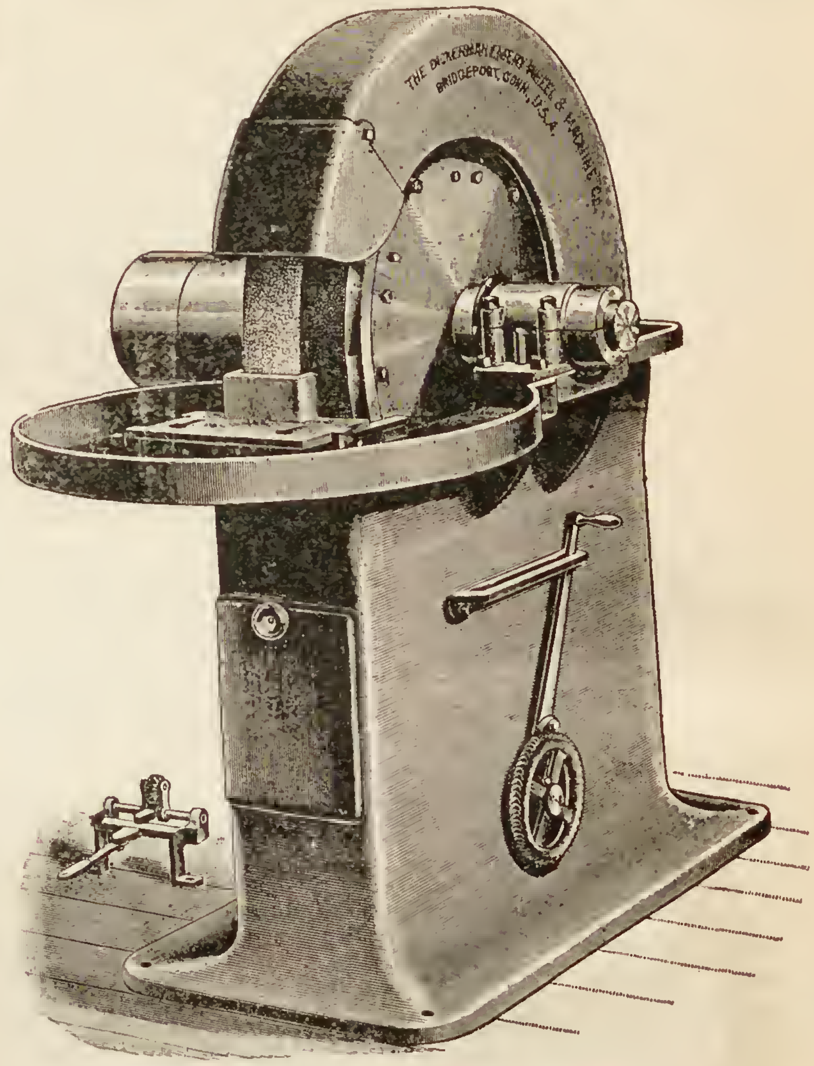
THE DICKERMAN TOOL GRINDER.

This machine is illustrated by the engraving herewith, and has a water-pan below the wheel and inside of the frame which carries it. This pan is adjustably arranged, so that it can be raised or lowered to allow the wheel to touch the water. The adjustment is effected and regulated by the lever on the side, but the pan cannot be raised sufficiently to allow the wheel to touch its bottom and grind it out. It may be removed for cleaning through the opening below the table, and fresh water can be supplied to the pan by pouring it on the table, from which it runs into the pan. The hood is so constructed as to protect the operator as well as the bearings and spindles from water and spray. The table is round, which enables the operator to be at the same distance from his work in whatever position he may be holding the tool to be ground. All the working parts are carefully and accurately finished, the shafts and bearings being extra heavy, and special balancing arrangements are provided for adjusting the wheel.

The machines are made of two sizes: one with a wheel 36 in. diameter and 3 or 4 in. face; the other has a wheel 20 in. diameter and 2½ or 3 in. face. They are made by the Dickerman Emery Wheel & Machine Company, of Bridgeport, Conn.

THE "MONOBAR" CONVEYOR CHAIN.

Monobar is the name given by the Link-Belt Companies to a new chain for long-distance conveying and elevating, which combines strength, lightness, simplicity and durable qualities, and is destined to take a leading place among new and useful



THE DICKERMAN TOOL GRINDER.

appliances for work of this class. Monobar may be briefly described as a series of bolts, flexibly connected, with attachments for conveyor flights or elevator buckets. Fig. 1 shows its appearance as employed in a conveyor, and will suggest to those familiar with chain conveying a superior advantage in that no material can lodge on the chain or be carried under the wheels. Its construction is shown in fig. 2, in which the malleable-iron joint is in light tint, and the abutting ends of

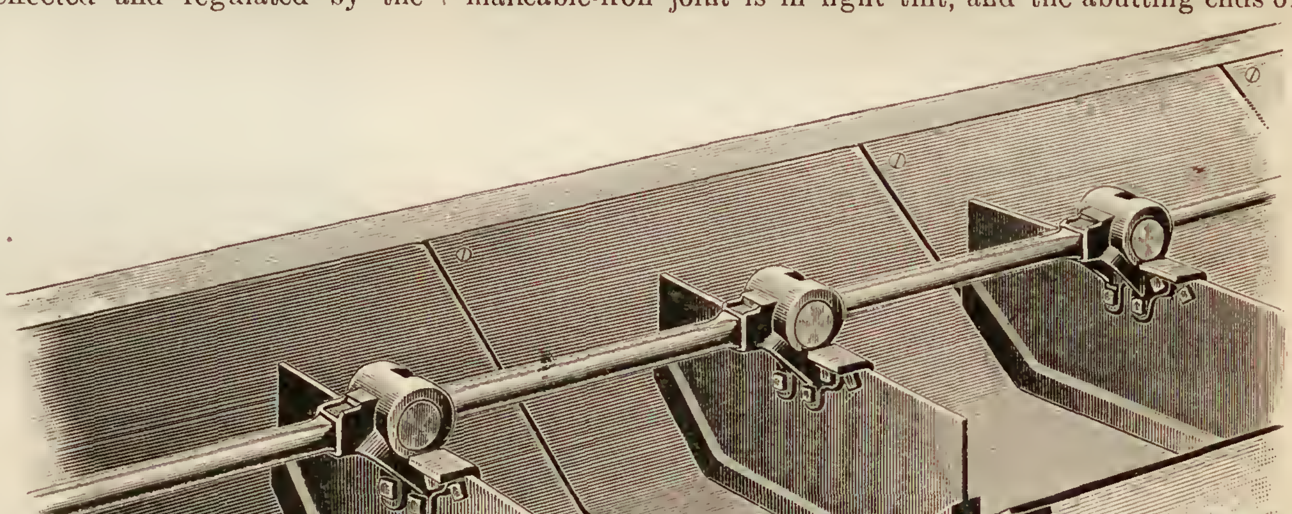


Fig. 1.

THE "MONOBAR" APPLIED TO A SCRAPER CONVEYOR.

the bolts in full shading. Having no welds, which are the chief points of weakness in wrought chains, and the malleable joints being so proportioned as to be in all cases stronger than

the wrought-iron bolts, the strength of the chain is that of a high-grade wrought-iron bolt of the diameter employed. This, for a 1-in. bolt, is about 29,000 lbs. No distortion occurring up to the actual breaking point of the bolts, the monobar is stronger for its weight than any other chain in use. Its design permitting and indicating the use of long bolts, the joints are relatively few, and both weight and wear are consequently reduced. It is detachable at every joint, and readily and quickly assembled or taken apart. Accurate adjustment to pitch is secured by turning the nut on the end of each bolt, and as the nuts are locked while in working position, this adjustment is permanent. The wearing surfaces are larger than in any known chain, and are designed for free lubrication while in motion. There is absolutely no wear on the bolts, so that restoration of the chain to its original condition requires only a renewal of the joints when, after long service, they have become worn out.

The first cost of manufacture being materially less than that of any standard chain for long distance conveying, the invention presents the double advantage of low first cost and cheap maintenance. The claims made for the monobar are substantiated by the record it has made in actual service. Conveyors in which it is employed as a chain, varying in length from 260 ft. to 600 ft. from end to end, have been in operation for some time past. One of them 450 ft. long has been operated for the past six months by the Kidder Coal Company at Wilkesbarre, Pa., in conveying culm from the bank to the washery. The conveyor has been in steady use 10 hours per day, exposed to the weather, and has been run without lubrication or attention. Under date of October 17 the Superintendent of the Kidder Coal Company writes:

"We have used four other styles of chain, and find the monobar conveyor superior to any of them. It is easy to disconnect, and costs practically nothing for repairs. The equalizing gears largely overcome the lashing or uneven motion caused by the long pitch."

The equalizing gears referred to are illustrated in fig. 3, and are of sufficient interest and importance to justify a somewhat complete description. They are designed to give uniform speed to elevator and conveyor chains. They counteract the pulsating motion imparted by the driving-wheels revolving at uniform speed, to chains of long pitch. This jerky motion is inherent in all chain and wheel mechanisms. Unfortunately it cannot be readily counteracted when chains of 6 in. or less pitch are employed, though equally destructive if less noticeable than in case of longer links.

In the illustration a seven-tooth sprocket-wheel is shown driving a chain of 18-in. links. As each link engages the driving sprocket it is controlled by a radius 20¾ in. long, measured from the centre of the sprocket-wheel to the centre of the hinge joint of the chain. When the wheel has made one-fourteenth of a revolution (or one-half the movement necessary to bring the next link of the chain into engagement with its sprocket) the controlling radius is reduced to 18¾ in. (measured from centre of wheel to middle of chain link). This action is like that of a connecting-rod, the horizontal movement varying in speed, though the wheel to which it is attached revolves uniformly. If the sprocket-wheel makes 10 revolutions per minute, these alternations of the chain speed occur 140 times per minute, and are necessarily fatiguing and destructive to the chain, producing a violent increase of the normal strain at frequent intervals without any useful result.

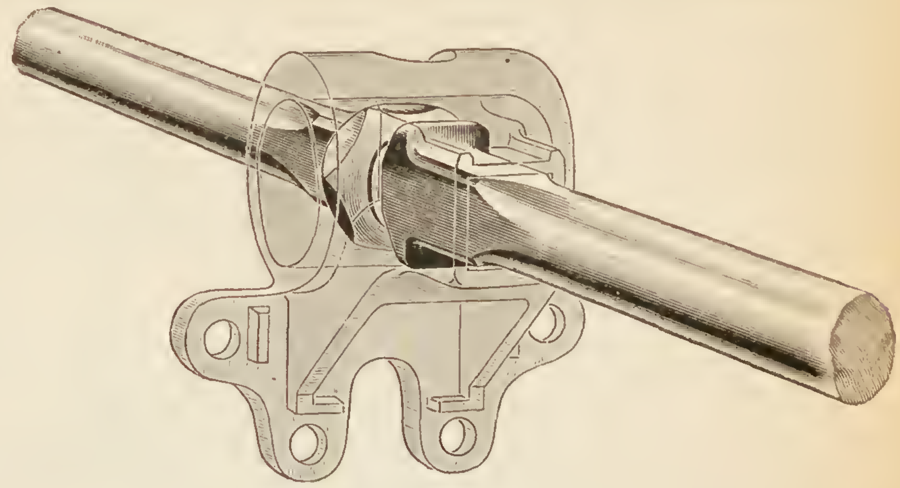


Fig. 2.

A JOINT OF THE MONOBAR CONVEYOR CHAIN.

The equalizing gears are designed to impart a pulsating motion to the driving sprocket-wheel exactly counteracting the variations in chain speeds above explained, and this is accomplished by making the pitch diameter of the spur wheel conform to a wave line, the number of elevations and depressions in this line corresponding with the number of sprockets of the chain wheel, and driving the spur-heel with an eccentric pinion as shown in the cut, the sprocket-wheel and spur-wheel being keyed on the head shaft in proper relative positions.

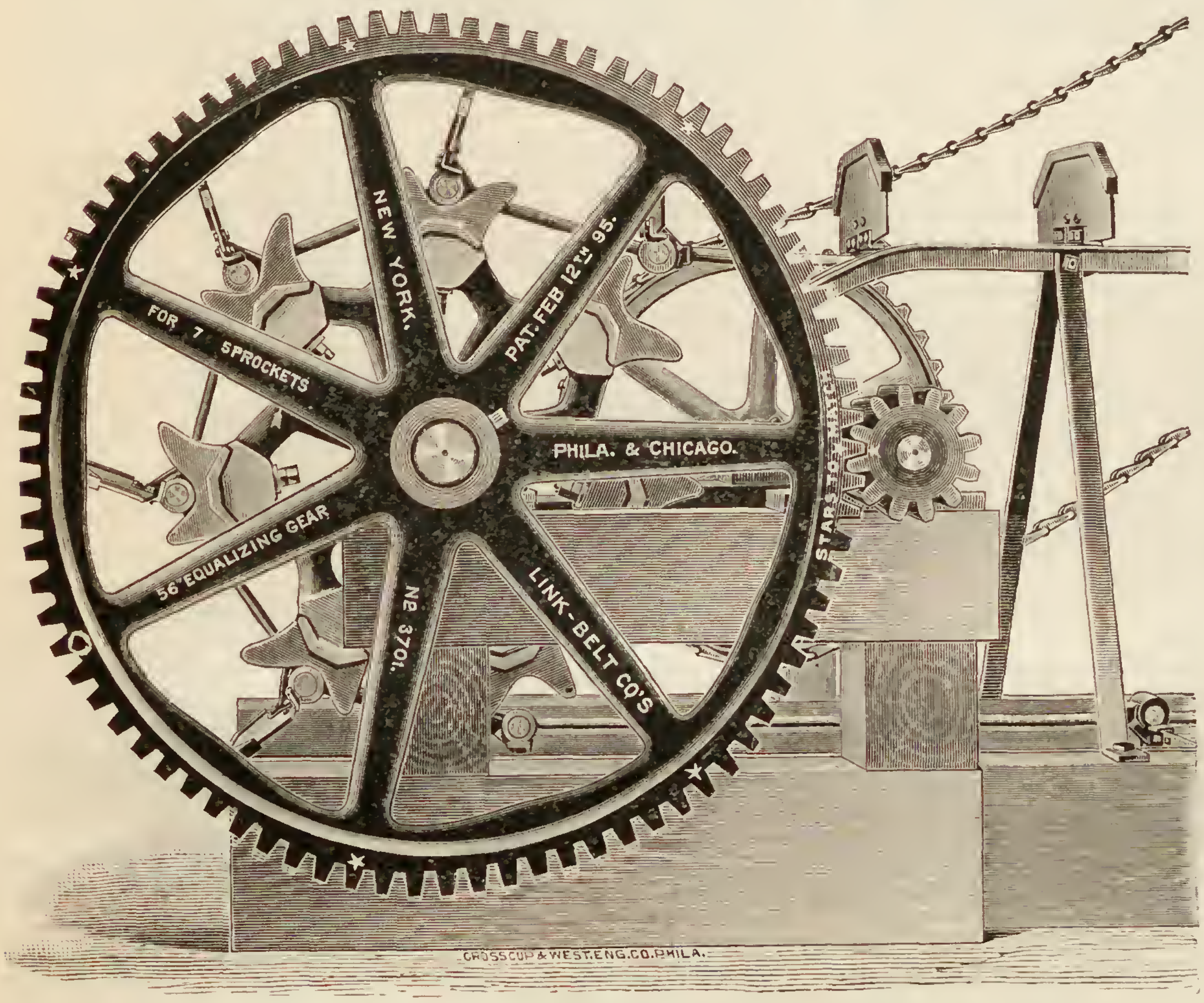


Fig. 3.

COMPENSATING APPARATUS USED WITH THE MONOBAR CONVEYOR CHAIN.

A series of exhaustive tests has developed the facts stated and proved the value of this gearing. By its use less power is required, and the destructive strains due to driving with circular gears is eliminated, thus permitting installations of greater lengths or the use of lighter chains.

The above described inventions mark a distinct advance in the application of modern methods to the handling of materials.

Recent Patents.

HENSZEY'S IMPROVED LOCOMOTIVE.

Mr. William P. Henszey, of Philadelphia, the well-known manager of the Baldwin Locomotive Works, has patented the improvements in locomotives shown in fig. 1, and which he describes as follows:

"The frame A is depressed at a in front of the fire box, so that while the portion A' is of one level and will readily ac-

commodate the axles of the large driving-wheels, the portion A^2 is on a lower level, and will readily accommodate the axle of the trailer and will extend under the fire-box to the rear of the locomotive, so as to be coupled to the tender. The lower portion of the fire-box rests directly above depressed portions A^2 of the frame A A, and by depressing the frames at the points a, I obtain the increased depth of fire-box and at the same time keep the width required, and as the frame is depressed I can extend the fire-box to the rear, increasing its length without interfering in any way with other parts of the locomotive. Consequently I can construct a locomotive that will have an increased grate area and a uniformly deep fire box that will give results not obtainable in other locomotives."

The following are his claims :

"1. The combination in a locomotive of the side frames depressed back of the drivers, the driving-wheels and trailers, the boiler, the fire-box, the sides of which are directly above the depressed portion of the frame and within the space between the oppositely arranged driving-wheels and the trailing-wheels, so that a wide and uniformly deep fire-box is obtained which extends forward between the driving-wheels, substantially as described.

"2. The combination of the frames A, A of a locomotive, depressed at a directly in front of the fire-box, the boiler and the fire-box of uniform depth, the side walls of the fire-box being directly above the depressed portion of the side frames and within the space between the oppositely arranged driving wheels and trailers, and having an ash-pit extending between the frames and grate-bars separating the ash-pit from the fire-box, substantially as described."

The patent is No. 545,797, and is dated September, 1895.

slow down or return stroke of the regulator-piston or the bracket.

In order to easily secure the proper adjustment of the regulating apparatus in general, and especially in such particular cases, the mechanism is so arranged that only the absolutely necessary part of the movement of the regulating apparatus, adjusted to a certain stroke, will be imparted to the register 5. In the construction shown in fig. 3 this is effected by the shifting of the position of the axis 11 of a bell-crank lever 12, which serves to establish connection between the regulating apparatus and the register of the furnace-door. Axis 11 of bell-crank lever 12 is situated upon a lever 13, which latter is adjustable by means of a screw 16. As axis 11 is in this manner approached or removed from the operator 3 of the regulator, less or more way is imparted to the register.

The connection between the register and the operator 3 of the regulating apparatus is as follows : The sliding-rod 9 is provided with an adjustable stop 15, whereby it is lifted by the operator. The other end of the sliding-rod 9 is connected to one arm of a bell-crank lever 12, from the other arm of which extends a connecting-rod 8 to a loose sleeve 7′ upon the pivot of the furnace-door. The sleeve 7′ communicates with a second sleeve 7 upon the same axis, which again transmits the movement by a rod 17 to the register 5 upon the furnace-door. The piston of cataract 1 is here raised in opening the furnace-door by means of a chain 20, which connects the furnace-door with operator 3. When the door is closed again, the chain 20 becomes slack and the operator 3 is free to sink back in the time to which the cataract has been adjusted.

The steam emitted from the perforations in the pipe 10 forms a mist above the burning fuel and mixes the air entering through the fire-door above the grate with the fire gases,

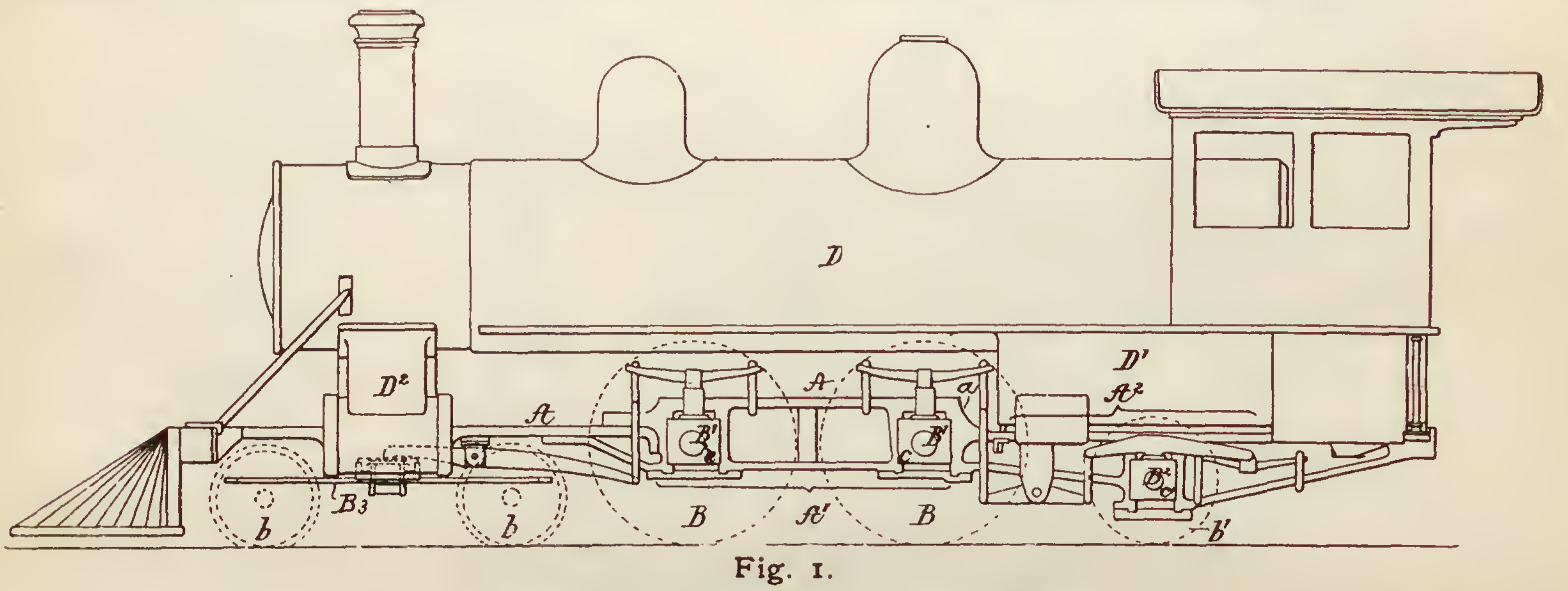


Fig. 1.

HENSZEY'S IMPROVEMENT IN LOCOMOTIVES.

LANGER'S SMOKE-CONSUMING APPARATUS FOR FURNACES.

Mr. Theodore Langer, of Vienna, Austria-Hungary, has patented in this country a smoke-consuming apparatus which consists of a steam-pipe 10, fig. 2, which in locomotive boilers is placed above the furnace-door opening in the back part of the fire-box or near the furnace-door at the top of the fire-box, as shown.

This pipe has perforations which are drilled in such a manner that steam-jets issuing therefrom will strike the tube-plate somewhat below the tubes, as indicated by the arrows in fig. 2. Although it is advisable to let the steam-jets or mist operate continuously, it is within the scope of this invention to insert a valve in the steam-pipe, which valve is operated and adjusted by the movement of an air-regulating apparatus.

The furnace-door 5, fig. 3, has a register for the admission of air to the fire-box. This is arranged so that when the door is opened the register will also be opened, and will then remain open for a short time after the door is closed, and will be closed gradually by an air-regulating apparatus 1, fig. 3. This consists of a cataract, as shown, or of a clockwork, etc., which operates in such manner that a part or bracket 3 of the same, carrying an arm, eye, or other means of connection 2, and which part 3 for brevity is designated the "operator," will within a certain predetermined time perform a certain stroke. This regulating apparatus is connected to the furnace-door, and is operated by the opening or closing thereof. The air register 5 consists of a slide or door, which is by preference connected with the regulating apparatus 1 in such manner that by the up or inward stroke of the piston or of the part or operator 3 of regulator 1 the register 5 will be opened to a certain degree, and gradually closed again by the

whereby a combustion of the smoke is effected. The area necessary for the air-passage after the feeding of the furnace, as well as the time after which the admission of air is to be stopped, must be determined by observation, according to which the regulator is adjusted.

Mr. Charles Brown, of Basle, Switzerland, writes us that he recently took a trip with one of the locomotives of the Rhigi Mountain Railway fitted with the new arrangement for consuming smoke, the invention of a Vienese engineer, Mr. Theodore Langer. "They are being introduced on several Swiss railroads which use the free burning bituminous coal of the Saarbruck Basin, the most outrageous smoke-producer I know of. Langer's apparatus works like magic, and seems to me more practical than the brick arch. It consists of a pipe in the fire-box with holes so as to produce two sheets of steam in the direction of the darts on fig. 2. The fire-door is made with segmental openings, which are opened when the door is opened for charging. At the same time it opens a valve connected with a pneumatic apparatus to keep the register opened for a short time after charging, and allowing it to close gradually as the fresh charge is ignited. It sets up a violent whirlpool in the fire-box and most effectually prevents smoke, and this *without* attention from the firemen."

The numbers of Mr. Langer's patents are 544,765, 544,767, and 544,766, which are all dated August 20.

Messrs. Charles A. Gras & Co., whose address is 61 Broadway, New York., are introducing this invention into this country.

AHERN'S STEAM-BOILER.

Mr. Denis Ahern, of New York City, patented about a year ago the curious boiler which, in the engraving, fig. 4, is

shown adapted to a vessel. From the illustration it will be seen it is substantially cubical in form, and is placed in a diagonal or inclined position, and has two sets of tubes extending through it at right angles to each other. At the lower back end there is a water-leg, A', which forms the back of the furnace, the grate E being placed below the cube. The direction and course of the draft is shown clearly by the arrows. Suitable casings I and J being placed on top and behind at some distance from the boiler, which thus provide space for the passage of the smoke and products of combustion from the top ends of the nearly vertical tubes at A to

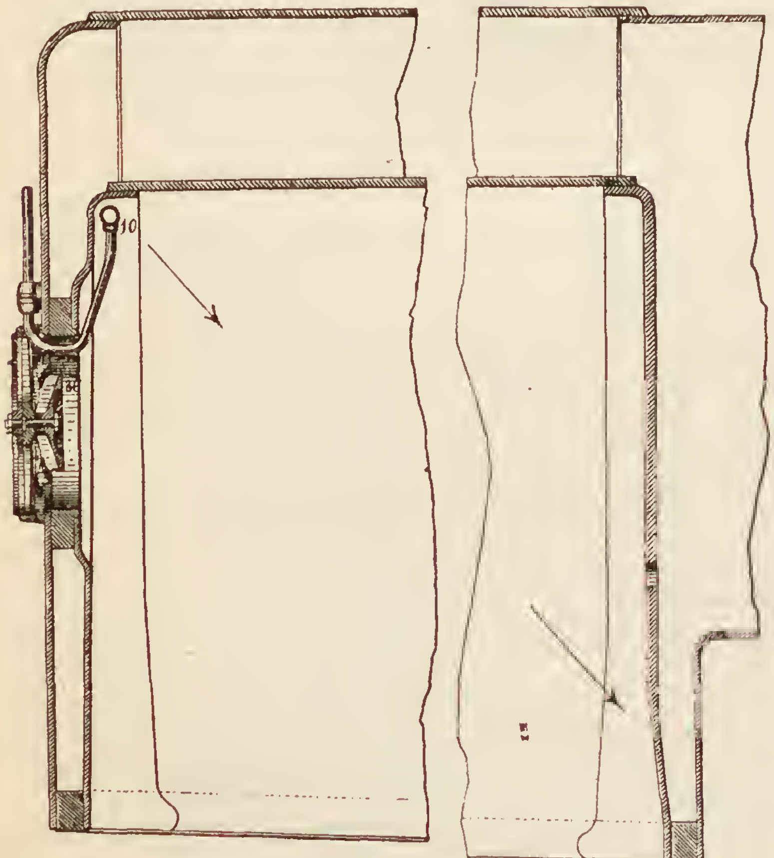


FIG. 2.

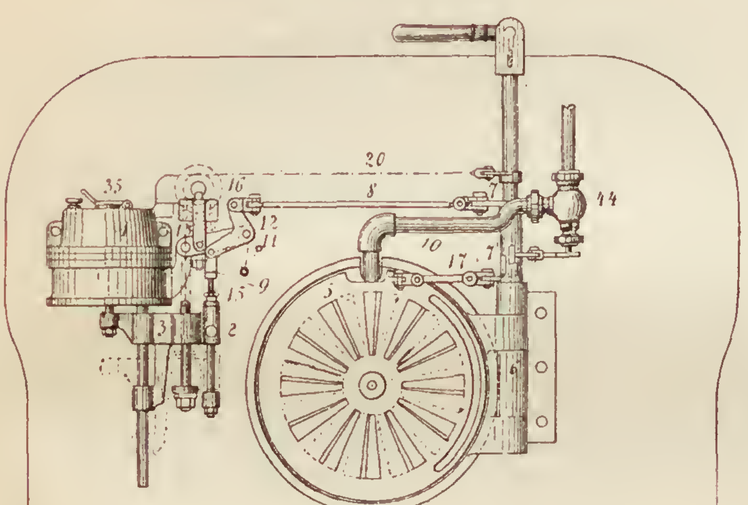


FIG. 3.

LANGER'S SMOKE-CONSUMING APPARATUS.

the lower ends of the horizontally inclined tubes B, and thence to the up-take G'. D is a steam-drum, which is exposed to the contents of the up-take, which thus have the effect of drying the steam. The boiler front is composed partly of horizontal tubes H, which are connected to suitable headers H^2, the upper ends of which are connected to the body of the boiler and the lower ends with the water-legs. These connections are, however, not shown in the engraving.

The patent is numbered 528,409, and dated October 30, 1894.

ROHAN'S STEAM GENERATOR.

The boiler illustrated by fig. 5 is the invention of Mr. James J. Rohan, of St. Louis, Mo. Its object, he says, is "to make a steam generator which shall be compact and efficient, and which is also particularly adapted to receive a down-draft furnace."

The boiler consists of a curved hollow shell 5 of a horseshoe form, which is connected to hollow flat ends or water spaces. In the centre of the generator is a cylindrical drum 15, which is also connected to the end water spaces. This drum is connected to the outside hollow shell 5 by radial tubes 16 ; 19 is a mud-drum, which is connected to the central drum 15 by water-legs 18 ; 24 is a steam drum suitably supported by

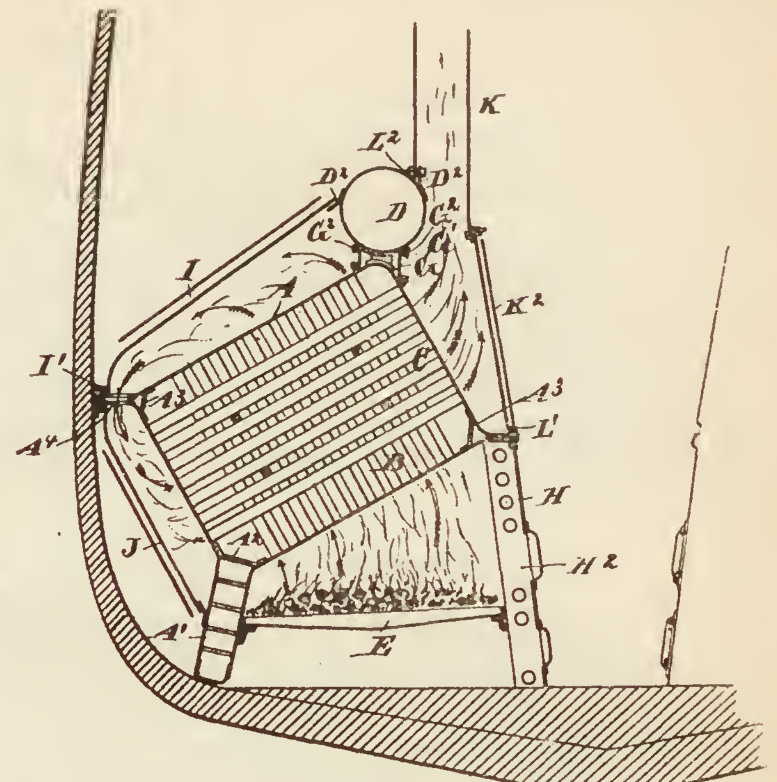


FIG. 4

AHERN'S STEAM BOILER.

tubular standards 23. Below the furnace-door 33 is another cylindrical drum 28, which is connected to the outer casing or of the boiler by vertical pipes 27, and to the central drum 15 by water-tube grate-bars 29. Below these is another grate 30 of the ordinary construction, which has a door 34 through which it may be fed. As shown by the darts, the draft is downward through the water-tube bars, and upward through

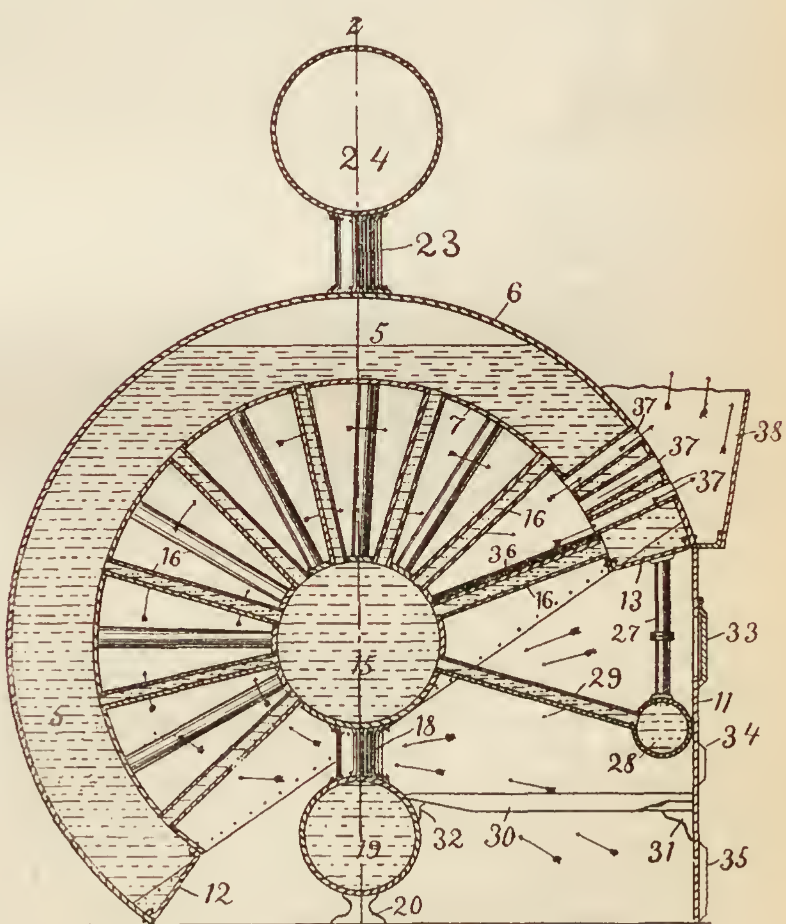


FIG. 5.

ROHAN'S STEAM GENERATOR.

the grate 30 ; the products of combustion from the two grates meet at 18, and then pass around the central drum 15 and escape through short tubes 37 to the up-take or stack 38. A suitable covering 36 is placed on the tubes 16 to divide the space above it from the furnace below.

Patent No. 546,786, and dated September 24, 1895.

SEE'S WATER-TUBE BOILER.

Mr. Horace See, the well-known mechanical engineer of New York, has patented the form of boiler shown by fig. 6. Its construction is so clearly shown by the engraving that no description is needed.

The patent is No. 546,715, and dated September 24, 1895.

JOUGHINS' RAILROAD CAR-TRUCK.

The car-truck illustrated by figs. 7–9 is the invention of Mr. George R. Joughins, Superintendent of Motive Power of the Norfolk & Southern Railroad, whose address is Berkeley, Va., which he describes as follows:

"The frame mainly of two beams of metal, each beam being bent, as shown, to constitute two half-sides *A* and one transom *B*. The transoms may be placed any convenient distance apart, with distance-pieces and tie-plates connecting them; but if placed back to back, as shown on the drawings, they may be simply riveted together. The transoms will also require to be slightly bent at their centre to give the necessary space for the usual centre pin, all forming a strong, simple, and cheap frame.

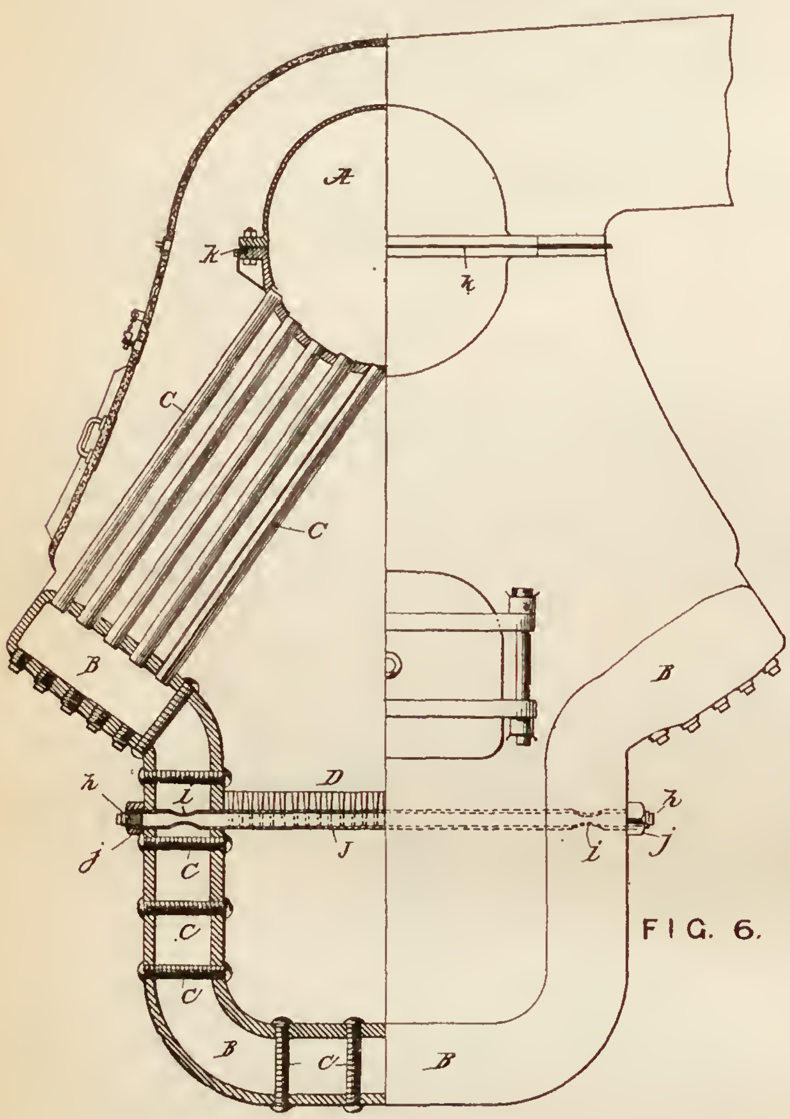


FIG. 6.

SEE'S WATER-TUBE BOILER.

"To form a jaw or pedestal for the accommodation of the journal-box, I split up the metal beam for a suitable distance from the end to *C*, cut out the superfluous material, then open it out and bend the top and bottom parts of beam to form the top and bottom parts of pedestals, as shown at *D* and *F*, then restore the strength of the beam by attaching in any suitable way over the split, which has been opened out, a piece of metal, such as *E*, or of any other convenient form, or by welding a piece into it.

"To facilitate the removal and replacement of wheels in the style of truck-frame described, and in which the journal-box has a vertical movement within the pedestals, I cut away part of the pedestal or jaw, as shown at *G*, for a sufficient height to easily admit the journal-box, leaving the bottom of the jaw permanently closed by prolonging the frame beneath the journal-box, as shown at *F*, so that wheels with attached axles may be rolled out of place as soon as the weight of the car is removed from them. The open space at the end is filled up with a removable piece of suitable shape, as *H*, which forms a shoe or rubbing-piece for the journal-box to rub against."

Number of patent, 547,379, dated October 1, 1895.

TAYLOR'S CAR-WHEEL.

Mr. William J. Taylor, of Bound Brook, N. J., has patented a method of manufacturing car-wheels, of which the following is a description:

"In the production of a wheel of my invention, shown by fig. 10, the ring, rim, or hoop to constitute the tread *a* is made of forged or rolled steel, and preferably of a composition or temper that will not flatten in service, and also that will give

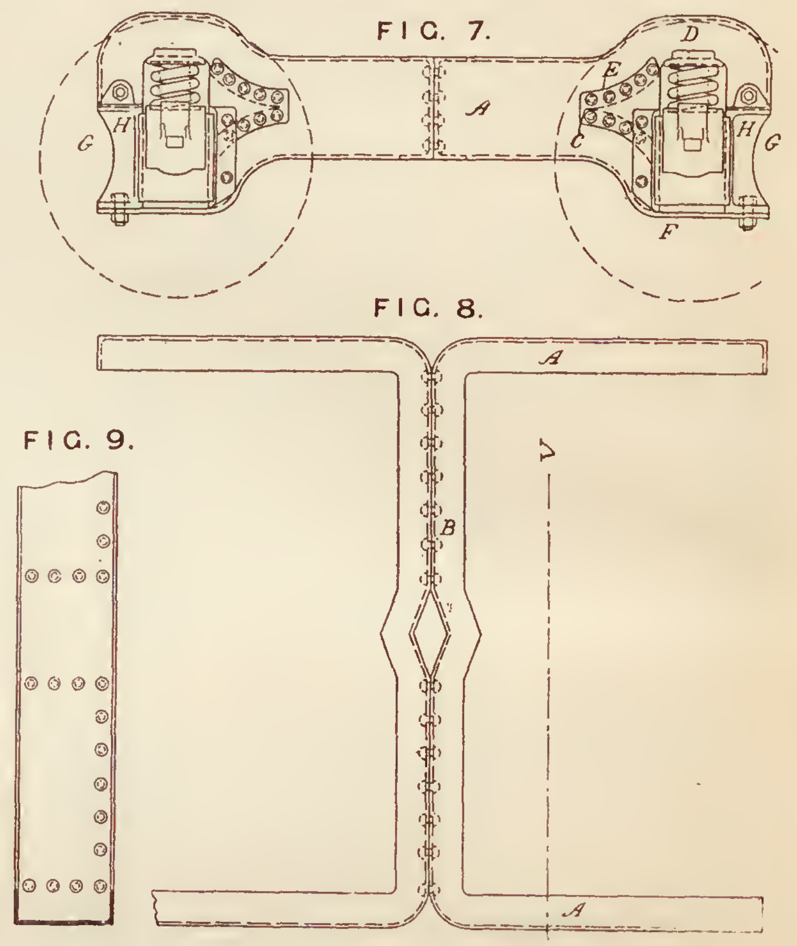


FIG. 7. FIG. 8. FIG. 9.

'JOUGHINS' RAILROAD CAR-TRUCK.'

good resistance to wear; and the flange is made of cast iron, as well as the body of the wheel, the flange being chilled in order to resist tendency to curve-wear in use.

"The mode of making a car-wheel of my invention is as follows: A ring, hoop, or tire of required dimensions and of substantially uniform thickness throughout, as illustrated in fig. 10, or slightly thicker on the edge or side next the flange, to constitute the tread of the wheel, is provided and is heated to required temperature, so as preferably to be welded to molten cast iron in order to form the body and flange of the wheel. This ring, hoop, or tire *a* is then introduced into a mould just before the metal to constitute the body and flange of the wheel is poured. The molten iron by such operation is fused or welded to the hot steel rim or tire, to form with the same one solid structure, while the flange of the wheel is chilled at the same time. It may be here remarked that when the steel ring, hoop, or tire *a*, constituting the tread, is welded to the body and flange of the wheel, it becomes such an integral part of the entire structure that no elongation and consequent loosening of the tire can occur, arising from the wear thereof. In a word, the life and duration of such a wheel is prolonged beyond any wheel hitherto known without apparent or actual flattening of the tread or of undue wear of the chilled flange of the wheel."

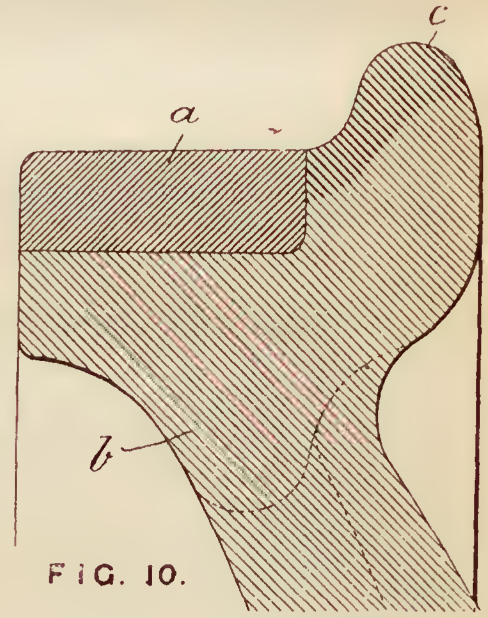


FIG. 10.

TAYLOR'S CAR-WHEEL.

Number of patent, 547,096, dated October 1, 1895.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

The American Railroad Journal, founded in 1832, was consolidated with Van Nostrand's Engineering Magazine, 1887, forming the Railroad and Engineering Journal, the name of which was changed to the American Engineer and Railroad Journal, January, 1893.

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NEW YORK, NOVEMBER 14, 1895.

EDITORIAL NOTES.

THE performance of the 10-wheeled Lake Shore locomotive on the recent fast run from Erie to Buffalo disposes of the last doubt as to the safety of this type of locomotive for fast runs, and also has shown that a very large wheel is not an absolute necessity. When we compare this engine with the English engines used on the Aberdeen run, all of which had larger drivers and larger cylinders, there is every reason to be well satisfied with the performance of the American engine ; and on the same day after this remarkable run the locomotive took her regular train West out of Buffalo without going to the shop for the recaulking of flues or other repairs.

THE difficulty that is experienced by the Navy in securing competent officers for the engineering department has been well known for a long time, and a recent movement having for its purpose the securing of suitable engineer officers is full of significance. Graduates of technical schools are to be invited to enter the navy, because of the reluctance of the graduates of Annapolis to enter the engine-room service. Graduates of Annapolis, who are thoroughly drilled to consider the line as the place for a gentleman and to look down upon their brothers of the engine-room as greasy mechanics, who have no rights that the officers of the line are bound to respect, naturally prefer the deck to the stokehold. It is barely possible, however, that if the department would shake off the conservatism that seems to enwrap it, and place the engineer officer on a par with the officer of the line, the difficulty of inducing the graduates of Annapolis to enter the engineering service would be to a great extent overcome ; but so long as the present state of affairs exists, it is natural that only those who have a taste for mechanics should elect to become an engineer. Surely the men who have charge of the maintenance and operation of such tremendous complications of machinery as our present battleships embody deserve the fullest recognition, and it seems to partake somewhat of the nature of a bunco game to attempt to induce the graduates of technical schools to enter a service wherein their whole previous training has been of such a nature as to render them totally incapable of comprehending the conditions that will surround them.

CAR VENTILATION.

IN these days of superabundance of literature, probably the rising and the latest-risen generation know little or nothing of the old-fashioned almanacs in which our grand and great-grandparents placed so much confidence. In pessimistic moods we are apt to think that this is the age of humbug ; but what modern fraud can equal the editor or publisher of the old almanacs, who, six or more months before the beginning of a year, assumed the gift of prophecy, and undertook to foretell not only what the weather would be for 365 days thereafter, but also threw in in addition thereto a number of miscellaneous predictions concerning a variety of other events. We old chaps remember the rude wood-cuts on each page representing the sower, the reaper, the shearer of sheep, etc., which were supposed to represent the occupations of the farmer in the respective months to which the engravings formed a sort of vignette. On the margin, or in the form of notes, the author would venture his predictions to the effect that about this time the reader should look out for storms, for heat or for cold, earthquakes, pestilence, influenza, or other diversions, which formed the bases for the comedies and the tragedies which afforded the real diversions of our ancestors.

If a railroad almanac were constructed on somewhat the same principles, the vignette for November would appropriately be a picture of a snow-plough, with the maxim, "In time of peace, prepare for war," paraphrased into, "*In the Indian summer, prepare for snow-storms ;*" and in the marginal note the prediction, "About this time look out for editorials on car ventilation." Certain occupations, duties, and diversions, such as the sowing of seed, heating of cars, and flying kites, are suggested by the vicissitudes of the seasons. It is so with the homilies on ventilation. In the marginal reading of the railroad almanac for the month of November might also be added, "About this season foul air and bad smells may be expected in railroad cars." When that occurs, then is the time for the railroad editor to get in his article on ventilation. That time is now.

To those of us who have been writing such articles for the past quarter of a century or more, the contemplation of this duty suggests the query whether, instead of writing another one, it might not be better to prepare a sort of an outline, analogous to what is called a skeleton sermon, for the use of our younger brethren, who, if they continue in editorial work, will frequently have occasion to write such articles, especially if they travel much and are gifted with an acute sense of smell.

In its general treatment the subject might be divided into two parts :

I. The importance of pure air and good ventilation, and the evil and disagreeable effects of vitiated air.

II. The means to be employed or how to secure good ventilation.

These two divisions of the subject might then be discussed under the following headings :

1. The hygienic importance of fresh air. (Under this heading almost any book on physiology or hygiene may be consulted, and ample evidence and material can be obtained to show the wholesomeness of fresh air and the deleterious effects of impure air.)

2. Definition : What is "ventilation"? (In the article under that title—"Ventilation"—in the *Encyclopædia Britannica*, it is said that "ventilation is the process of changing the air of rooms and other closed places so that a certain standard of purity may be preserved, notwithstanding the vitiation which

the air undergoes from the breath of inhabitants, the products of combustion of illuminating agents, and other causes." Amplifications which may be made on this text are obvious.)

3. The impurities with which the air of inhabited rooms is vitiated. (The most ready index of these impurities, it is said, is the amount of carbonic acid contained in the air. This, however, is not the only test of vitiation, and not even the most dangerous impurity. The amount of oxidizable organic matter it contains is another index ; but perhaps the most dangerous impurity is the micro-organisms, especially bacteria, contained in the air of badly ventilated rooms. It is said that an habitually close room becomes a sort of nursery of those dangerous occupants. This branch of the subject may lead out in many directions. Some one has said that a knowledge of modern bacteriological science made him feel as though he was an old cheese, infested with maggots. If one of the purposes of such an article as is here outlined is to make railroad travellers feel uncomfortable, there is ample opportunity for dilating on the unspeakable filth which is breathed in an ordinary car, and a great variety of horrible diseases might be described which may be caught there through the insatiable energy for colonization possessed by these aggressive bacteria.)

4. The standard of purity which should be maintained in the air of a car or room. (This will probably be somewhat analogous to our standard of morality, to which some of us try in a more or less ineffective way to conform as closely as we can, but always find ourselves very far from our criterion. Ordinary out-door air is assumed to have about four parts of carbonic acid to 10,000. It is assumed, too, by some authorities on ventilation, that air should not under any circumstances contain more than 10 parts in 10,000. To maintain this degree of purity requires that 1,000 cub. ft. of fresh air should be supplied to each person per hour. Other authorities say that the supply should be *at least* from 3 cub. ft. to 4 cub. ft. for each person per minute, or from 180 to 240 per hour—a wide difference from the first quantity named. An obvious inference, therefore, is that the greater the amount of fresh air which is admitted, the better will be the ventilation. The most perfect ventilation is out-of-doors, where the supply is unlimited. The doctrine may, therefore, be inculcated that it is well to admit as much fresh air as possible into cars consistent with the comfort of passengers.)

5. How to determine the amount of carbonic acid and micro-organisms of a car. (The chemists have devised various methods for ascertaining the quantity of this deleterious gas in the atmosphere, and it is said "the micro-organisms may be caught by slowly passing a given volume of the air to be examined through a tube coated inside with beef jelly ; the germs are deposited on the nutrient jelly, and each becomes in a few days the centre of a very visible colony." Happily for us, it is said that these organisms do not increase very rapidly unless they have time and a suitable medium to breed in. It would be interesting if some bacteriologist would take samples of old plush from car seats which has been absorbing carbonic acid and been colonized by bacteria for a decade or longer, and ascertain what kind of population occupy its territory. We know that the *cimex lectularius* and *pediculus vestimenti* are often found there, and probably minuter organisms also find lodgment in its texture, and possibly in great numbers. These are suggestive topics, and if properly worked up might add greatly to the existing apprehensions and terrors of railroad travel.)

The second division of the subject would fall under the following heading : How to ventilate a car.

Here the writer would do well to again refer to the encyclopædia article from which quotations have been made. The author of it says that "in order that the atmosphere of a room should be changed by means of air currents, three things are necessary :

"(*a*) *An inlet or inlets for the air.*

"(*b*) *An outlet or outlets, and*

"(*c*) *A motive force to produce and maintain the current.*"

Owing to their importance, they have been italicized. The writer goes on to say of them, "that one might think it need less to enumerate such obvious requirements were it not that, in providing appliances which are intended to act as ventilators, one or other of these essentials is not infrequently overlooked." This seems to be especially true of car ventilation. It is singular too what curious superstitions are believed in with reference to ventilation. One of these is the delusion that to ventilate an apartment of any kind, all that is needed is to make an opening of some kind at the top, and that the air will then very obligingly proceed to flow out of that aperture. Ordinarily it will do nothing of the kind. If the reader has ever undertaken to drive a drove of pigs which have broken into a corn field out through a gap in the fence he will find that they are inclined to go everywhere else excepting through such an outlet. In his efforts to surround the pigs and drive them out, he may learn a lesson in ventilation. Air, like the pigs, is averse to escape unless it is forced to do so. As a matter of fact, we are living at the bottom of a great ocean of air. We might get a clearer idea of the condition of things if we would imagine that we were all mermen or mermaids, and that the bottom of the ocean was our dwelling place, and that railroads and railroad cars existed there, and that we all breathed water instead of air, somewhat as the fishes do. It will be imagined, further, that in some aquatic train a car was occupied by 60 voyagers, and that the water in it became vitiated. What folly it would be to expect that if a number of openings were made in the top of the car, that the water in it would immediately flow out! It would be impossible for it to do this unless some other water was admitted to take the place of that which escaped. If the car were not water-tight, or if its doors or windows were opened, some fresh water might thus enter, and a corresponding quantity of that in the car might escape ; but the supply of fresh water would thus be in a great measure accidental, irregular, and uncertain. To have a constant supply, provision would have to be made for that which is impure to escape, and *also* for the admission of an equal supply of fresh water. Besides this, the water in the car, like all other inanimate matter, would be inert. It would have no disposition to move unless compelled to. A motive force would be required to move it. This might be supplied by the buoyancy produced by warming the water, or from currents produced by the movement of the train, or from mechanical means, such as a pump. Exactly analogous conditions exist at the surface of the earth. These are at the bottom of the great ocean of air. To change that in a car, provision must be made for a quantity of bad air to escape and an equal quantity—enough to keep that which is breathed reasonably pure—to enter, and some *sufficient* motive force must be supplied to cause the air to move. It will not do it of its own volition, or because we may want it to do so. Adequate INLETS, OUTLETS, and MOTIVE FORCE are three absolute essentials to produce good ventilation. Unless we have all of them it will be impossible.

In a rapidly moving railroad train there is little difficulty in providing the two last, and, quite curiously, it is these which have received most attention, and on which there has been the greatest amount of ingenuity and thought exercised. It is as though a person should devote his time and attention to devising ways and motives for spending money, and make no effort to supply an income. That has been tried very often, and has never succeeded. The difficult problem in ventilation, then, is how to admit an adequate supply of fresh air to a car.

There is little or no trouble in exhausting or getting the bad air out of a car. If a back door or back window is opened it will escape fast enough, if only an equal amount is admitted

somewhere else. The great difficulty is that the incoming air in winter causes discomfort because it is cold, and in summer because it is mingled with dust and cinders. The problem of car ventilation, then, really resolves itself into the question of how to admit enough fresh air without causing discomfort to the inmates. Those for whom this article is intended are, therefore, advised to consider ways and means for doing this. The exhaust, as has been said, will give little trouble. Since the introduction of the asphyctic vestibules the uncertain supply which formerly entered through the open doors and ventilators in the ends of the cars is denied to the passengers. The vestibules form a sort of tunnel which conducts the vitiated air from the front end of the train to the back, and thus the carbonic acid and other exhalations from the bodies of passengers, with the dreadful micro-organisms of various kinds, are carefully kept inside the cars instead of being allowed to escape. In a recent railroad journey a drawing-room car, of which the writer was an occupant, was placed immediately behind a dining car, the kitchen of which was at the back end, and the two were united by a vestibule. The consequence was that "we" and our fellow-passengers were inhaling the atmosphere of a scullery during the whole journey of 143 miles.

We venture the prediction that the time is not far off when the owners of railroads and most managers will have a realizing sense that vestibules are an expensive humbug. They are not only costly, but they are heavy, they obstruct ventilation and ingress and egress to and from cars. The only thing which they accomplish which may not be done by much simpler and cheaper means is that they prevent dudes and dudettes from soiling their gloves in passing from one car to another. When they are used, the admission of air at the end of the car—the most advantageous point for its entrance—is impracticable, or, at least, difficult.

Of the admission of air, the writer of the article which has been quoted from says :

"With regard to inlets, a first care must be to avoid such currents of cold air as will give the disagreeable and dangerous sensation of draft. At ordinary temperatures a current of outer air to which the body is exposed will be felt as a draft if its velocity exceeds 2 ft., or at most 3 ft. per second. The current entering a room may, however, be allowed to move with a speed much greater than this without causing discomfort, provided its direction keeps it from striking directly on the persons of the inmates. To secure this, it should enter, not horizontally nor through gratings on the floor, but vertically through openings high enough to carry the entering stream into the upper atmosphere of the room, where it will mix as completely as possible with warm air before its presence can be felt. A favorite form of inlet is that shown in the engraving. When opened it forms a wedge-shaped projection into the room, and admits air in an upward stream through the open top."

That this method of admitting air is very effective in producing good ventilation can be shown experimentally in any cars heated with stoves and provided with slatted blinds at the windows. If the end window in front of the stove and the corresponding one at the back end of the car are raised 6 in. or 8 in., and the blinds are lowered, the movement of the car will cause a current of air to flow inward at the forward end, and it will be deflected upward by the slats in the blind, and as it enters the car it will be mingled with the ascending currents of hot air around the stove, and it will thus be delivered into the car at a comfortable temperature, and in a current above the heads of the passengers. At the same time, there will be an outward current drawn from the window at the back end, through which the vitiated air will escape. The warm air from the stove at this end, it is true, will be drawn out of the car, which would, of course, be objectionable in very cold weather. A car may, however, be throughly well ventilated in this way.

The objection to this method of ventilation is that more or less smoke and dust are carried into the car through the window. For this reason ventilators were long ago placed above the end windows, in which position they are under the projecting roofs over the platforms and are protected from cinders, and, being higher up than the windows, less dust is admitted when they are in that position. Slatted registers have also been used in such ventilators.

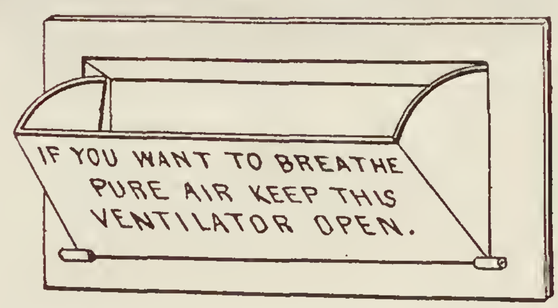
Sliding windows in the doors of cars are also much used, especially in sleeping cars, and are an excellent means of cooling off a car when it is too hot; but they produce disagreeable drafts, especially in cold weather. End ventilators in clearstories are also much used, and usually have a door or wicket, which is hung on what may be called trunnions, placed on a horizontal centre line transversely to the car. The air which enters under this door is not directed upward, but falls on the heads of the passengers near the front end of the car; and as mankind have a wholesome dread of cold drafts, as soon as such currents are felt the ventilator is apt to be closed. Besides this defect, such ventilators are often made too large; and thus, when they are opened in cold weather, too great a volume of air is admitted and the dreaded drafts are felt, and it becomes difficult to keep the car warm. By making the inlets to such ventilators in the under side of the projecting roofs over the platforms, and protecting them with fine wire netting, some dust and many cinders will be excluded.

The best possible arrangement for the admission of air to a car would seem to be a ventilator somewhat like the one shown in the illustration, and having an area of about a square foot of area, and placed in the end of the clearstory, with an inlet in the roof over the platform and protected with wire netting. This arrangement is, however, impracticable when vestibules are used; but if that useless luxury is insisted upon, doubtless the inlets could be placed in some other locality, where they could be supplied with fresh air from out-of-doors.

As an accessory to the care and use, and as a permanent instruction to the public and to the railroad employés of the purpose and objects for which such ventilators are intended, they should each have inscribed on them in letters easily legible from any part of the inside of the car :

IF YOU WANT TO BREATHE PURE AIR, KEEP THIS VENTILATOR OPEN.

There is a chance for some enterprising manufacturer of car furnishings to make a comfortable profit by making ventilators of this kind, and placing them in the market. But whoever makes them, he should keep in mind that the inscription is important for its educational effect. It is a rather remarkable fact that a comparatively small proportion of the



public seem to know that a ventilator is needed to admit fresh air. Their only conception of the function of such appliances is that they are intended for the escape of air when the car is too hot. Most railroad employés and many officers hold the same opinions.

The purpose of our article is to impress upon those who are responsible for the ventilation of cars, that the essential thing for them to aim at is to provide means for the admission of as much fresh air into cars as possible, consistent with the comfort of passengers. There is not the least danger of getting too much in, provided the passengers are kept comfortable. The more the better.

As a specific recommendation, it is believed that a form of inlet ventilator, somewhat like our illustration, will be the most effective, and if not absolutely the cheapest, it will certainly cost very little. The inscription, which is considered very essential to its effectiveness, will cost nothing after the patterns are made. It is not patented, and the only expense which railroad companies might reasonably object to is our hoped-for commission for the suggestion and the design.

NEW PUBLICATIONS.

The Safety Valve has been purchased by *The Coal Trade Journal*, and the office removed to the Times Building, New York.

Poor's Manual of the Railroad of the United States.—This annual publication comes with the certainty of fate and the regularity of taxes. It contains this year 1,412 pages of text, or 20 pages more than last year. It is, of course, the same immense storehouse of statistics and data among railroads that it has always been, and is simply indispensable to those who have business with railroad companies.

Le Vol Sauté (Leaping Flight). By Edmond Alix. In French. Paris: G. Masson. 135 pp., 51 figures, $6\frac{1}{2} \times 10$ in. 6 francs.

We have here a new theory of flight by Dr. Alix, who published in 1874 an elaborate essay upon the locomotive apparatus of birds. In the present volume he follows this up by a full description of the physical structure of three birds: the swift, the swallow, and the goatsucker; and, having passed in review their general characteristics, he gives in great detail their osteology or framework and their myology or arrangement of muscles. These descriptions take up the first 112 pages of the book, when, having described the machinery, the author advances a new theory as to its action, referring more particularly to the termination of the downward wing stroke. He says:

"By a rapid, almost instantaneous movement, while the hand (outer end of the wing), through its spread primary feathers, obtains a bearing on the air, the forearm is abruptly extended against the hand, while the arm is extended against the forearm.

"There results a pressure against the shoulder, which generally obtains upward, inward and forward. This pressure, through the medium of the shoulder bones, drives all the body of the bird.

"In this movement the bird leaps upon his wings; and as we conceive this to be the true mechanism of flight, we have termed it 'leaping flight,' as distinguished from other conceptions, and more particularly from that termed 'rowing flight.'

"At the moment of the leap the wing is not folded; it is already more or less extended and spread out, but not entirely. In leaping, the wing fully completes its extension—it is a sinuous surface which abruptly straightens out.

"The wing's leap is so rapid that it escapes observation; it is *the real effective movement which is not seen, and which explains the results of the apparent flap, which alone is visible.*

"It is an intrinsic movement of the wing which sometimes coincides with apparent immobility, and sometimes is concealed in the general movement.

"It is not, therefore, by beating the air with his wings that the bird flies, but by spreading his wings and leaping thereon when fully spread out. It is through this leap that the bird darts forward like an arrow."

Then the author describes in detail the working of the mechanism in effecting these results, and calculates the muscular force which must be expended. He comes to the conclusion that the tension upon the motor muscles is but little more than the weight of the bird; that the power required for mere support is not great, and that it is not much greater at normal speed.

All this may or may not be true. It seems difficult to prove or to disprove the existence of a movement which the author himself says cannot be distinguished, although he shows it to be anatomically possible; but it is interesting to compare this theory with the old one of rowing flight, and of the final "whip lash" action which is supposed to confer forward propulsion.

TRADE CATALOGUES.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. The advantages of conforming to these sizes have been recognized, not only by railroad men, but outside of railroad circles, and many engineers make a practice of immediately consigning to the waste-basket all catalogues that do not come within a very narrow margin of these standard sizes. They are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

STANDARDS.

For postal-card circulars	$3\frac{3}{4}$ in. $\times$ $6\frac{1}{8}$ in.
Pamphlets and trade catalogues	$3\frac{1}{2}$ in. $\times$ 6 in. 6 in. $\times$ 9 in. 9 in. $\times$ 12 in.
Specifications and letter-paper	$8\frac{1}{4}$ in. $\times$ $10\frac{3}{4}$ in.

The number of specimens of this kind of literature has accumulated on our hands to such an extent that it makes it necessary to condense our notices into less space than we have heretofore ordinarily given to such reviews.

"The Boys" have Something to Say about Dixon's Pure Flake Graphite. Joseph Dixon Crucible Company, Jersey City, N. J. 16 pp., $5\frac{1}{2} \times 6\frac{7}{8}$ in. [Not standard size.]

This company recently sent out samples of their graphite to locomotive engineers for trial, and have published in the pages before us the reports of their experience in its use, and the results.

Surface Grinding and Polishing Machinery. Diamond Machine Company, Providence, R. I. 8 pp., 6×9 in. [Standard size.]

The publishers here describe a number of machines which they make for grinding and polishing. The illustrations are excellent wood-cuts, and the descriptions are full and clear. They report increasing business.

The Correspondence School of Technology, Cleveland, O. 60 pp., 6×9 in. [Standard size.]

This school has been organized for instruction in engineering through the mail, similar to the Scranton School. The courses and methods of study are fully described and explained, which is the purpose of the publication. The offer of a special commission to students who obtain other students does not, however, produce a good impression.

The Electric Storage Battery Company. Sole Manufacturers of the "Chloride Accumulator" Drexel Building, Philadelphia, and 66 Broadway, New York. 52 pp., $6 \times 8\frac{1}{2}$ in. [Not standard size.]

The purpose of this pamphlet is to describe the chloride accumulator, which is also illustrated, but with rather a poor quality of engravings. The description, however, is very full, and will interest all who are concerned in electric matters.

W. D. Forbes & Co, Engineers and Manufacturers, Hoboken, N. J.

This firm have issued a descriptive catalogue of 20 pp., 6×9 in. [standard size], in which the high-speed automatic engine, yacht engine, milling machine, revolution counter, hydraulic hand pumps, and the national chucks, all of which they manufacture, are illustrated and described.

Catalogue of the Gisholt Machine Company, Madison, Wis. 44 pp., $6 \times 9\frac{1}{4}$ in. [Not standard size.]

The specialties which this company make are turret lathes and screw machines. A number of different patterns of these are described and illustrated by half-tone engravings. The latter half of the book is devoted to illustrations of different pieces and kinds of work which can advantageously be done on these machines, and to some descriptions of the methods of doing it.

J. A. Fay & Co., of Cincinnati, have issued a large placard about 2 × 3 ft., containing illustrations of their works and wood-working machinery, and which they request in red letters should be hung in a conspicuous place. Unfortunately wall space is too valuable in New York to permit us to comply with their request; but doubtless their customers, potential and actual, who have unlimited shop room, will take pleasure—and have profit, too—in complying with their instructions.

Price-List of Improved Hydraulic Screw and Lever Jacks, etc. Watson & Stillman, 204–210 East Forty-third Street, New York. 37 pp., 5½ × 8 in. [Not standard size.]

The first statement made by this firm in their price-list is, "Cash in New York bankable funds," which is a good basis to begin on. This is followed by a description of their jacks and directions for using and repairing them. In the remaining pages engravings, descriptions and prices are given of the various kinds they make. Among the articles of their manufacture are also portable double screw hoists, and the Tonkin three-roller adjustable and single size expander, which they say "is the best in the world."

Illustrated "Catalog" of Quint's Turret Drills. A. D. Quint, Hartford, Conn. 20 pp., 6 × 9 in. [Standard size.]

The machines described in this "catalog" are a vertical drill press, in which from two to 12 drill spindles are carried by a turret whose axis is horizontal. Each of these spindles has a bevelled pinion which is driven by a wheel in the turret on a horizontal shaft. They are so arranged that only the spindle and drill in use revolves. The illustrations are good wood-engravings, excepting the diagrams on page 11, which are process work, and are made on too small a scale to show clearly.

United States Metallic Packing Company's Price-List. Philadelphia. 26 pp., 6 × 9 in. [Standard size.]

The publishers have given in this list blank specifications for their packing, intended, apparently, for ordering it; illustrations and prices of locomotives, stationary and marine engine and air-pump packing; McDonald's balanced valve; the Gollmar bell-ringer; Norris' lever lock mechanism; the McIntosh oil-cellar and oil-cup for engine truck and driving-axle boxes; Saylor's portable drilling, reaming and tapping machine; a valve stem clamp for holding a valve if an engine should break down; and oil-cups of various kinds, all of which they make.

Catalogue of Automatic Cut-off Engines, built by J. H. McEwen Manufacturing Company, Ridgway, Pa. Office, Havemeyer Building, New York. 30 pp., 5¾ × 9 in. [Not quite standard size.]

This company has given in their very neat catalogue illustrations of the interior of their shop, external views of their horizontal tandem compound, simple vertical, and horizontal engines. They have also an excellent sectional view of a horizontal simple engine, and various views of different parts and details showing their construction, with descriptions thereof. The book ends with tables giving powers and dimensions of their different engines.

Monolithic Subways. Sewers, Electric Conduits, Drains, Cable and Electric Roads, Ditches, Water Pipes, Tunnels, etc. The Ransome System. Ransome Subway Company, Monadnock Block, Chicago. 24 pp., 6 × 9 in. [Standard size.]

In this pamphlet the method which has been patented by Mr. Ernest L. Ransome of making continuous or monolithic pipes and conduits of various kinds of concrete is described and illustrated, and the advantages of the system are explained. The illustrations do not deserve a very high degree of commendation, but perhaps they serve their purpose, which is all that can reasonably be demanded.

Mr. Ransome has devised a continuously moving and adjustable mould, around which concrete pipe is formed, the mould being of such a shape as to make all parts of the work accessible to the workman. The pipe is of course made in the position which it is intended to occupy, and is without joints.

Various reports and opinions on the merits of this method of construction are added in the form of appendices.

1895 Catalogues and Price-lists of Machinery, Tool and Castings, Standard Rules, Cast-steel Try-squares, Wire Gauges, and Tools for Accurate Measurements 366 pp.

This is a new edition of a catalogue which is issued annually, and which contains a great deal of interesting and valuable information to practical machinists and those engaged in mechanical engineering work of any kind. The new volume contains about 60 pages of new matter, and describes many new tools and appliances which have recently been brought out by the publishers, and which will interest practical mechanics who take a pride in knowing all that is to be known about their occupations. The book will be found very useful for reference, as it contains data not easily accessible elsewhere, concerning gearing, tools of precision, cutters of various kinds, micrometre calipers, gauges, etc. Persons who aim at being supplied with the most approved appliances for doing work in the best way and at the lowest cost should have this catalogue within reach.

From the Frick Company, of Waynesboro, Pa., we have received the following catalogues:

Corliss Steam Engines. 114 pp.

High-Speed Automatic Steam Engines Described and Illustrated. 56 pp.

Refrigerating and Ice-Making Machinery. 216 pp.

These are all 6 × 9 in. [standard size], and are deserving of very high commendation, as they are about all that a trade catalogue should be. They are elaborately illustrated, with general views of the machines made by this company, which are either half-tone engravings or very excellent wood-cuts. Besides the general views there are detailed engravings showing the various parts of the machines, with excellent descriptions accompanying them. Those representing the valve gear of the Corliss engines may be particularly commended for fulness and clearness. Very good views of the interior of the shops are also given. Only an extended review of these publications would do them justice, and for that we have not room. We will take space, though, to say that the company are manufacturing: 1. Automatic high-speed slide-valve engines, both simple and compound, horizontal and vertical; 2. Corliss cut-off engines, also simple and compound, condensing and non-condensing, vertical and horizontal; 3. Refrigerating and ice-making machinery for all kinds of purposes. It would be manifestly improper for us to say that any one wanting such machinery could not do better than to get it from the Frick Company; but we will say that persons who contemplate getting engines or refrigerating machines will be without a very valuable source of information if they have not examined the Frick Company's catalogues before they decide where to place their contracts.

Car-Buyers' Helper. How a Good Car Differs from a Poor One, and how to Get it. Brownell Car Company, St. Louis. 172 pp., 6 × 9 in. [Standard size.]

The sub-title of this book might leave the reader in a little doubt whether the author intended to indicate how to get a good car or a poor one, were it not for the fact that the Brownell Company are not supposed to build poor cars.

In the preface it is said that the book "has been made to give the reader a sufficient knowledge of electric and cable cars to enable him to negotiate for them advantageously."

With this object in view, engravings are given in the first chapter of the framing or skeleton of a car, and also the panelling. The construction of these, and also the strains to which they are subjected, are then explained. The next chapter contains a series of illustrations showing the details of the joints, trussing, panelling, roof, platforms, etc., with descriptions of how they should and how they should not be made.

The third chapter is on the Cheapening of Cars, and discusses the material used in their construction, the method of making panels, glue and glueing, "scrims," etc. Chapter IV is largely devoted to painting and varnishing, bolts, bronze for trimmings, seats, plush, carpet, glass, and "everything else." Street-car Builders are also discussed in a separate chapter, which is followed by another on Specifications, and a sort of skeleton for proper specifications is given. Then there are observations on Getting Bids, Inspecting, First Class and Cheating Car-Builders, etc. In a chapter near the end, the "Accelerator Car," which was designed for the Broadway Road, in New York, is described and illustrated, and, apparently, it is to this chapter that all the previous ones lead up. The advantages of this car are very fully set forth, and a very funny horizontal sectional plan is given, showing a car of this kind crowded with people. The observer is supposed to be looking down on the heads of the passengers. Various other views of these cars are given, and their advantages are fully set forth. The last chapter is devoted to Mr. F. B. Brownell, the author of the book and the president of the car company, and gives his history.

The style of this production might be called boisterous, and reminds one of the Mississippi River taken at full flood, on

whose banks the writer of it dwells. His little brochure is, however, full of valuable suggestions, and is one of the very few good books on car-building in existence.

COAL HANDLING FOR STEAM GENERATION. C. W. Hunt Company, 45 Broadway, New York. 52 pp., $6\frac{3}{4} \times 9\frac{1}{4}$ in. [Not standard size.]

Although it is not said so specifically, it is intimated on the first page of this catalogue that with the machinery which is described in it coal has been taken from the hold of a vessel which came at irregular times, stored it in a 6,000-ton pocket 800 ft. distant, then took it from the pocket and delivered it continuously, day and night, to the front of boilers for a cost, including the interest on the investment, of less than $3\frac{1}{2}$ cents per ton, and that the reduction of the cost of handling 25,000 tons of coal per annum by this means was from $27\frac{1}{2}$ cents to the figures named, which represented a net profit of $6000 per annum. The catalogue is devoted to the description of machinery required for doing this kind of work, which is a specialty manufactured by the C. W. Hunt Company. The general character and purposes of these appliances for handling coal is indicated in a description of the plant furnished to the Edison Electric Illuminating Company of Brooklyn. The work to be done at this station, it is said, "was to take the coal from the wagons, carry it to storage bins above the boilers, weigh it, deliver it to the furnaces, and to remove and dispose of the ashes. The coal is carried from the hopper underneath the sidewalk to the coal tanks above the boilers by a conveyer which, upon its return, passes under the furnaces and carries the ashes to a storage bin, from which they can be drawn into carts at will. The conveyer used to do this work consists of a series of gravity buckets pivoted in a double chain, and the whole system is carried on self-lubricating wheels in the manner shown in the illustrations."

Besides the plant referred to, the general arrangement and appliances used in other locations are illustrated and described. Among them are those at the Brooklyn Water Works; the Brooklyn Heights Railroad Company; the Fifty-second Street Railway Station; the Metropolitan Street Railway Company, in New York; the Edison Electric Illuminating Company, in Boston; the Baltimore City and Suburban Railway Company; the Detroit Citizens' Railway; the United Electric Light and Power Company, of New York; the Philadelphia & Reading Terminal Company, of Philadelphia; the Brooklyn Elevated Railroad Company; the Manhattan Elevated Railroad Company, and one for the Boston & Maine Railroad Company. These are illustrated by views made from photographs and sectional and other engravings, which show in some cases the general arrangement of the plant, and in others the details of special parts and appliances. The descriptive matter is very satisfactory, and altogether the catalogue is an interesting one, which those having charge of the handling of coal will find very useful.

HIGH PRESSURE STEAM. The Babcock & Wilcox Company, 29 Cortlandt Street, New York. 38 pp., $7\frac{1}{2} \times 10\frac{3}{8}$ in. [Not standard size.]

What is in reality the introductory text of this volume is the statement that in 1875 the pressures carried on the best class of stationary plants did not average over 65 lbs., in 1880 about 90 lbs., in 1890 about 125 lbs., and to-day pressures ranging from 185 lbs. to 250 lbs. are not uncommon where the highest economy is required, driving compound, triple and quadruple-expansion engines.

That high pressure has come to stay is assumed by the publishers of the catalogue under review, an assumption which probably will not be questioned. Brief descriptions and illustrations are then given of the boilers exhibited at the Centennial Exhibition in Philadelphia in 1876. In all there were 11 sectional and three "shell" boilers exhibited. Of these it is shown that the three shell boilers—fitted to carry low pressures—have survived in the same form, and that only the Babcock & Wilcox, of all the sectional boilers, is still made of the same design, although the Root boiler has been but slightly changed. At the Chicago Exhibition in 1893 not a single shell boiler, it is said, was exhibited under steam. The conclusion which it is intended should be drawn therefrom is that if high pressures are to be employed, sectional boilers must be used. It is said that "for high pressures, boilers with shells of large diameter, whether internally or externally fired, are no longer admissible. Their deterioration under heavy strains is too rapid to warrant the danger of running them."

In this connection the fact that all of the three shell boilers exhibited in Philadelphia have survived, in substantially the same form, to the present time, while of 11 sectional boilers only two have survived, cannot be ignored. Then, too, it is said that "for many years the pressures carried on locomotives in this country greatly exceeded those carried on stationary plants. It started at about 100 lbs., rose to 120 lbs. in 1860, to 150 lbs. in 1880, and at the present time as high as 180 lbs. pressure is carried on compound locomotives." These high pressures have uniformly been generated in shell boilers, with a considerable portion stayed.

The conclusions inculcated in the publication under review are that boilers must be made to carry high pressures, not only temporarily, but for a long term of years, and that the sectional form of boiler is the only one which will do this safely. Such boilers should be made so that they can be cleaned and inspected from the outside, and the units of which they are composed can be removed and replaced. Cast metal, it is said, is uncertain, and should not be used in the construction of boilers.

To indicate the character of the work which they do, the Babcock & Wilcox Company have appended a copy of a complete blank specification under which their boilers are manufactured. Numerous views of their works and also engravings showing details of construction of their boilers are given.

The engravings, paper, printing and general designs are all of the best, and are from the press of Bartlett & Co.

NOTES AND NEWS.

South African Exhibition.—There is to be an International Exhibition of the South African Republic at Johannesburg during the months of May and June, 1896, which offers to American manufacturers a good opportunity for making their products known in that far-off but rapidly growing country. It will open on May 1, and remain open during that month and June, and will be conducted under the auspices of the International Exhibition Company and the patronage of His Honor, S. J. P. Kruger, State President, South African Republic. The Company may be addressed by mail or telegraph at Johannesburg.

Car Ventilation.—At the meeting of the American Public Health Association, which was held in Denver in the early part of October, Professor S. H. Woodbridge, of the Massachusetts Institute of Technology, read a paper on Car Ventilation, in which he stated the requirements to be as follows:

"The air must be furnished by other than natural means so called. The supply rate must be as little as possible affected by the movements of the coaches or the wind; the air must be continuously and regularly supplied in generous quantity, the action of the system being plenum rather than vacuum, in order to reduce the inward leakage of cold air, smoke, dust, and cinders. The heat should be generated at the floor, and evenly distributed and well regulated. The air should be entered warmly and cleaned, and in such a manner as to reach effectively all occupied parts of the car. To avoid disturbing wind or air pressure effects, either a velocity must be given to the air entering from the outside highly in excess of that which the average maximum pressure would produce, or the inlet pressure must be automatically regulated with reference to pressure, so as to insure convenience of flow. A high efficiency fan would be requisite—one that would have 1,800 revolutions per minute and be 18 in. in diameter. It would be run in a chamber especially designed for free-air movement, and would run with avoidance of noise if moved by a $\frac{1}{2}$-H.P. rotary steam motor, taking its supply from the steam beneath the cars and passing its exhaust either into the heating system or outward. The fan might be run (though at more cost) by an electric motor, the electricity for the dynamo coming from a belt connected with the axle-wheel.

"A suitable filter to cleanse the air of smoke and dust and readily movable for cleansing could be made. Such a filter would consist of a box of square 40 ft., made of fine wire gauze and fibrous material such as cotton wool, placed back of the wire netting.

"To introduce air into a coach without danger of annoying local drafts, and to adapt the method to sleeper, parlor, and day coaches alike, one or more overhead channels through which the air could be delivered laterally to one-half of the car could be made practicable. The monitor roof construction would furnish ready accommodation for such an arrangement. The air-density at 65° would cause it to settle downward with moderate action, and the location of inlet and outlet could be chosen so as to cause the air once delivered into the car to take up a movement toward the other end from that at which it was supplied. At the other extremity it should be given a free ceiling discharge. If desired the supply could be given a floor delivery by substituting for the guards which now cover the steam pipes boxes about two-thirds of a square foot free area, each one of the boxes opening beneath the seats for the delivery of air. But this would not be so desirable."

If this plan were carried out it seems as though it might be

necessary to appoint a graduate from the Institute of Technology or some other similar school to travel with each train to superintend its ventilation. It was said at the same meeting that the Wagner Palace Car Company had opened a special school where its employés are instructed in the proper cleaning and ventilation of cars, which is good news, as some of them need instruction—or rather knowledge—on these subjects very much. We are disposed to believe that the removal of the modern vestibules from trains would do as much for ventilation as anything else. They exclude a great part of the small amount of fresh air which passengers were formerly permitted to breathe. The vitiated air from the front end of the train now passes through to the back end, and the more that is allowed to escape from the rear cars, the greater the amount which is drawn into them to take the place of that which is exhausted. The paramount question in all systems of ventilation is where and how an adequate quantity of fresh air is to be supplied. If enough pure air is admitted, there will be no trouble in allowing that which it should displace to escape.

Test of Armor and Ship.—The Naval Ordnance Board conducted a most important and successful test at Indian Head proving grounds on September 4. Primarily it was a test of steel armor plate, but really of greater importance. It was a trial of the strength of the frames of modern warships, which it had been claimed would not withstand the shock caused by heavy projectiles against the armor covering them, some authorities even going so far as to assert that the armor, if not shattered or penetrated by the shot, would be driven through the vessel by the crushing of the frames. This was the first frame test ever made of distinctly modern warships, though the English Government some years ago did fire at an antiquated armored vessel for the purpose of observing the effects of the shot.

The experiments demonstrated the fact that the frames of our warships are perfectly able to meet all ordinary demands. It was also demonstrated that the new 14-in. armor with which the new battleships will be protected can, under ordinary conditions, receive the fire of any vessel afloat without serious damage. A test was also made of a new armor bolt designed by the Ordnance Board to replace the bolts now used in fastening armor to the ships, which are weighty, cumbersome, and expensive. Each of the three tests was entirely satisfactory. The armor plate far exceeded the prescribed requirements, the counterfeit frames bore the shocks without impairment, and the bolts were entirely satisfactory.

The plate tested represented 24 others, weighing 620 tons, made by the Carnegie Company for the battleship *Iowa*, now building at Cramps'. It was the first service test of the company's new process of making what is known as double-forged armor, being forged both before and after carbonization or Harveyizing. Heretofore it has not been forged after being Harveyized. This plate, 14 in. in thickness, formed the outer surface of a target, which was an exact reproduction of a side section of the battleship *Iowa*. It was 18 ft. long by 7½ ft. high, and represented that portion covering the vitals, and extending 5 ft. below and 2½ ft. above the water-line. Behind the armor was a backing of 5 in. of oak, and then came the "skin" of the vessel—the inner and outer bottoms, each five-eighths of an inch of steel plate. Some 4 ft. further back was a ⅝-in. steel plate, representing the inner shell of the vessel. Between this plate and the "skin" were the frames or braces, also of ⅝-in. plate, alternately 2 and 4 ft. apart. The whole structure was covered by a 2½-in. steel plate, representing a protective deck. Against the inner plate were heavy timbers resting on the side of a hill.

It would seem at a glance that the conditions were not the same as on board a ship in the water for the reason that the water would yield, while the solid earth would not. But the naval officers calculated that this difference would be very light, as the vessel in the water could not yield quickly enough to be of any benefit.

The first shot fired was from a 10-in. gun, a Carpenter projectile weighing 500 lbs. being propelled by 140 lbs. of brown prismatic powder, and attaining a velocity of 1,472 ft. per second, and a striking power of 741,000 foot-pounds. The shell was completely shattered by the impact, only the point being imbedded in the plate, which was not otherwise injured. So loose was the point in the plate that it fell out entirely from the concussion caused by the third shot. The backing and frames were found intact.

As this shot had made scarcely any impression, the charge of powder was increased on the second shot to 216 lbs., giving the 500 lbs. projectile a velocity of 1,862 ft. per second. As before the shell was shattered, a larger portion, however, being imbedded in the plate, which was still without a crack or bulge. One of the armor bolts was driven out, the thread being sheared off; but this was expected to happen when a bolt is struck by a shot. Several of the small bolts holding the protective deck were broken, but this was not considered material, for the reason that the bolts were used as a makeshift, a metal joint being the usual method employed. This completed the acceptance test for the lot of the 24 plates, and they will undoubtedly be approved.

Then one shot was fired from a 12-in. gun. A Wheeler sterling projectile, weighing 850 lbs., was urged along by 400 lbs. of powder at a velocity of 1,800 ft. per second. This test was ordinarily employed on 17-in. plates, and it was thought that it would pass entirely through the 14 in. of steel, and the backing, frames, etc., as well. While the plate was penetrated almost its entire depth, and cracked from top to bottom, the oak backing was scarcely disturbed, and the outer skin and the frames were not disturbed at all. Another armor bolt was forced out, and the rest of the bolts in the protective deck were snapped off. So this plate not only stood the test for its own thickness, but constructively for a 17-in. plate.

The new armor is less than half the length of the bolt now in use, and the saving in weight in each ship will be considerable. In addition, the packing used with the old bolts is quite an item, as a brass cylinder, a spring washer, and rubber rings are necessary, whereas in the new ones ordinarily tow packing, with a lead washer, suffices. The test was made under the direction of Captain Sampson, Chief of the Bureau of Ordnance, and was witnessed by Secretary of the Navy Herbert and the Board of Ordnance. A further test, this time with a 13-in. gun, will be made as soon as the gun can be set up.—*New York Sun.*

Guns of the British Battleship "Majestic."—The *Majestic* is the first large ironclad which has been built since the *Royal Sovereign* class, and yet, with the exception of the Hotchkiss guns, there is not a single gun or mounting on board the *Majestic* that does not show some marked improvement on those of her immediate predecessors. The *Majestic* is armed with four 12-in. Woolwich wire guns, in barbettes; twelve 6-in. Elswick quick-firing (wire) guns, four on the upper deck and eight between decks; sixteen 12-pdr. Elswick quick-firing guns, and twelve 3-pdr. Hotchkiss quick-firing guns, on Elswick recoil mountings. Interest naturally centres on the 12-in wire guns and their mountings. The guns themselves are of Woolwich design and manufacture, but before their design was approved of the representatives from the leading firms of gun-makers were called in and asked to criticise. As the design was put into execution it may be presumed that it was considered satisfactory. It embodies a very full development of the wire or ribbon construction, no less than 102 miles of wire being wound on each gun. The wire is rectangular in section, and it is wound on with an average tension of 40 tons to the square inch. Jackets of steel are put on the gun outside the wire, so that as far as external appearance is concerned they do not differ from an ordinary steel gun. The breech mechanisms of the 12-in. guns have been designed with a special view to rapidity and ease of manipulation. The only fault that can be found with them is that they are somewhat complicated, but, as one man can open the breech in about six seconds, even after firing proof charges, a little complication is excusable.

The method of securing the guns to their cradles—and now we pass from Woolwich to Elswick designs—is quite new. Instead of the broad bands passing over and strapping the gun on their cradles—as in the *Royal Sovereign* class and previous ships—"thrust rings" are provided to the 12-in. guns which fit into corresponding grooves in the cradles and thus transmit the longitudinal thrust of recoil. Slots in the rings and keys keep the guns down in their places. The arrangement actually in use for securing the guns to their cradles are thus all below the axis of the guns, and are well protected. There is another new feature about this method of attachment. It will easily be understood that for convenience the breech screws of guns in a turret or gun-house have to work to opposite hands, the breech screw of the right-hand gun hinging on the right-hand side of the gun and the breech screw of the left-hand gun on the left-hand side. At first sight it appears that to effect this the guns themselves would have to be right and left-handed, a system which would cause, and has hitherto caused, a liberal and costly supply of spare guns. But the Elswick plans get over this by arranging that the guns shall be reversible. If it is required to place the right-hand gun in a left-hand position, it is only necessary to turn it upside down. The "thrust rings" encircle the gun and therefore always coincide with the grooves in the cradle, and slots are provided in the rings to meet the requirements of either position. Each gun with its complete mounting is made to balance (when the gun

is out in the firing position) upon a pair of trunnions. These trunnions are fitted to the slides and are strong enough to transmit the shock of recoil to the structure of the turntable, as well as to take the whole weight of the gun and mounting. The object of the balancing is to make it possible to give elevation or depression to the gun by hand, and still retain recoil in the line of fire. The guns may be run in or out by hydraulic pressure. In firing, it is only the notion of running out that is necessary, for the recoil will always bring the guns in ; but for cleaning purposes and drill it is convenient at any time to have the power of running them in. Hitherto guns in the Navy worked by hydraulic power have been loaded in the "run in" position, but the *Majestic's* guns are loaded when run out. Much more room is thus obtained in rear of the guns for the loading operations. In the *Royal Sovereign* class there is but the one fixed loading position—that is to say, after each round the turntable has to be brought to a certain fixed position and locked there until the operation is over. If one gun only has been fired, the other has to be practically put out of action for about two minutes until the first has been reloaded. In the *Majestic*, however, in addition to the fixed ammunition hoist, which has been retained with the idea that to load both guns simultaneously it is the quickest system, there is a central or all-round loading hoist for the supply of the powder, and a considerable stock of projectiles stowed in the gun-house provides the other essential. Thus either gun, or both guns, can be loaded in any position, and the loading of one gun does not in any way interfere with the working or firing of the other. To sum up, every operation can be performed by hand, should the hydraulic gear—which is, however, almost completely duplicated—break down. The guns can be loaded simultaneously at a fixed position or separately at an all-round position, and the time necessary for working the guns has been much reduced. As to the barbettes, the name is somewhat a misnomer, for the guns have a shield or house covering them which can hardly be distinguished from a turret—indeed, the advocates for the two rival systems of barbette and turret seem, in the *Majestic*, to have agreed to a compromise. The sloping sides and roof of the gun-house offer no surface to a direct hit from a projectile. The plating is 10 in. in front.

During a recent trial it is said the guns and the hydraulic gear worked to perfection and with the greatest smoothness. There was not the least hitch anywhere. All the guns were fired with cordite, and the ordnance officers seemed to be very favorably impressed with the new explosive.—*London Times.*

Electric Cable Railway up the Stanserhorn.—The inclined road up the Stanserhorn is the last which has been built in Switzerland, and presents in its general dimensions and special arrangements some points of considerable interest. The Stanserhorn is a mountain whose summit is 6,234 ft. above the level of the sea—that is to say, at a height intermediate between its two neighbors, Pilatus, 5,965 ft., and Rigi, 5,905 ft. This mountain rises above Stanserhorn, the chief town of the canton of Negii, and from which summit is seen the magnificence of the Bernese Alps, the Lake of the Toncan, and the mountainous regions of the northwest of Switzerland. The means of access are very easy. Steamboats run from Lucerne to Stanserhorn, where an electric tramway takes one in 15 minutes to the Stanserhorn Hotel, the point of departure of the tramway which is the subject of this note. This tramway is a trolley line run by electricity furnished by the same motive power as the cable line. The latter was opened in August, 1893. The difference in level to be traversed being 1,850 − 450 = 1,400, and the length about 13,124 ft., would have been too great for a single cable railway even though the contour might be all right which utilized at certain points the bed of a torrent, and which necessarily required repeated and constant curving. Therefore, the line is divided into three successive cable lines involving the trans-shipment of passengers at two intermediary points. The first section lies from Slais to Ketio, and has a difference of level in 714 − 450 = 264 metres. The length traversed on a horizontal line is 5,099 ft., but by following the grade, which is 5,085 ft., the inclination varies from 12 to ½. The second section runs from Ketio to Blumett, the difference between the two points being 2,313 ft., with a length of 315 ft. on a horizontal line and 3,576 ft. on the grade. The grades are necessarily steeper, and vary from 40 to 60 per cent.

The third section starts from Blumett at an altitude of 4,006 ft. and runs to the hotel of Stanserhorn, 6,070 ft., making a rise of the section 2,064 ft. with a length of 4,183 ft. on the grade and 3,642 ft. on a horizontal line. The grades vary in the preceding case from 40 to 60 per cent. It includes several prominent structures of considerable importance, one a tunnel of 460 ft. in length, and a viaduct of the same length. From the hotel of the Stanserhorn a guide shows the way in a few movements to the summit of the mountain, which is located about 600 ft. away. Each section is composed of a single track with a passing point at the centre of its length. Each has two cars attached to the ends of a cable which passes over a truck driven by a dynamo. This installation is placed at the upper section of each station—that is to say, at Ketio and Blumett and at the summit.

The dynamos take their current from their water-power station and a water-power and electric station located at Boochs, 3 miles distant, where a fall of the Aa drives the turbines. In addition to the water-wheels there is a supplementary steam engine of 60 H.P. for driving dynamos in case there should be any interruption. The car bodies are in staircase form, and they are divided into four compartments for eight persons each, with the same number upon the platform ; they can thus carry 40 passengers. The most original peculiarity of the Stanserhorn railway is the entire absence of the racks. The brakes act, not upon a tooth wheel, but directly upon the rails. They are formed by powerful apparatus which grips the rail under action of the right and left-hand screw ; this screw is driven by a wheel which by an ingenious arrangement is driven by the wheels of the car, which slacken off on the tension of the cable and fits in contact with a friction wheel. It is a combination of the Croix-Rouss and Heberlein brake. The rails have a special contour so that the jaws can act upon them. They are the Vignole type. At first sight the absence of the rack on grades of 60 per cent. would seem slightly rash, nevertheless many severe tests have been made by the technical inspectors of the department of railways, and have shown that there is every confidence to be placed in this system. There are two pairs of ties, each of which can exercise a pressure of 29,772 lbs. The second pair driven on the platform acts as a hand brake. It cannot be doubted but that doing away with the rack, which always costs at least 20 francs per metre, will very considerably reduce the expense of construction. Experience will show whether this saving is not met by more or less serious disadvantages. The two tracks come nearly parallel to each other at the two intermediate stations, so that passengers have only a few steps to take to go from one car to another. And this is done under cover ; the time used for running each section is the same, so that trains arrive at stations together. The speeds, therefore, are not the same ; thus, upon one section the cars run 394 ft. a minute, and on the other only 279 ft. Each run occupies 13 minutes, so that with the time necessary for the transferring of passengers 45 minutes are required for the whole run. The vertical rise is therefore 10,935 ft. per minute, and the speed of transportation along the grade varies from 46 ft. to 39 ft. 5 in. per second—3 to 4½ miles per hour. This is a very slow speed ; but it should be remarked that if this difference in level was traversed in shorter time by an ordinary railway, it would require a grade of 3 per cent. running 37½ miles per hour ; and on a grade of 6 per cent. the limited adhesion would cut the speed down to 18.64 miles per hour. It is possible, therefore, to go from Lucerne to the Stanserhorn hotel in one hour and a half. There are 10 trains each day. The passage is $1.52 for the round trip by the cable line. A similar calculation to the preceding would make it 1 cent per mile for equivalent distance over a railway with 3 per cent. grades. This line was built by Bucher & Durer, who had already built the one on the Burgenstach, which is also an electric traction road, but running to a lesser height. Upon this latter there is a rack line on the Abt system.

THE MOST ADVANTAGEOUS DIMENSIONS FOR LOCOMOTIVE EXHAUST-PIPES AND SMOKE-STACKS.*

By Inspector Troske.

It is well known that the efficiency of a locomotive depends more upon the steaming qualities of its boiler than it does upon the proper dimensions being given to its principal parts and the adhesive weight that may be upon its wheels, and that this steaming quality is, in turn, dependent upon the combustion taking place upon the grate, and that this is finally dependent upon the strength of the draft. If this latter is too weak, the fire burns sluggishly and the steam production is low ; while, on the other hand, if it is too strong there will be many pieces of unburned coal drawn through the flues, which will accumulate in the smoke-box as cinders, oftentimes even blocking up that space, or a portion will be thrown out of the stack as sparks ; either case serving to increase the coal consumption unnecessarily. The draft may even be so violent, as a result of improper dimensions being given to the

* Paper read before the German Society of Mechanical Engineers.

exhaust-pipe and the smoke stack, that in many locomotives it will be found that the fire no longer rests quietly upon the grates, but dances up and down upon them ; which not only has the evil effect of increasing the consumption of coal by a very appreciable amount, but admits more cold air through the air spaces into the fire-box than is actually needed for maintaining combustion. This excess of air lowers the temperature in the fire box and the tubes, and as a consequence injures the production of steam. By contracting or enlarging the mouth of the exhaust-pipe, we know that we can easily increase or weaken the draft, but there are well-defined limits in both of these directions. Contraction goes hand in hand with an injurious back pressure upon the piston, resulting in just so much work lost by the locomotive ; while an increase in the diameter of the pipe causes a lessening of the vacuum in the smoke-box and fire-box, so that finally the equalizing reserve action of the exhaust disappears, and the four exhausts for each revolution of the driving-wheels are always sharply defined from each other, the steam, instead, as is the case when running at high speeds, of approaching continuity, now issues from the stack under separate impulses, and thus no longer acts uniformly upon the fire, but in a jerky manner. These are, therefore, the outlying limits to good and economical consumption of coal.

Furthermore, we are dependent, not only upon the proper size of the exhaust nozzle, but also upon its position below the bottom of the stack opening, and upon the dimensions of the stack itself—that is, upon its diameter, height, and position. These four dimensions have no less influence upon the action of the fire and the generation of steam than the exhaust nozzle itself. As with the exhaust nozzle, so by enlarging or diminishing the size of the stack, the draft may be lessened or increased, also by shortening or lengthening the same, and finally by raising or lowering the exhaust nozzle with reference to the stack.

I.—HISTORICAL SKETCH.

Soon after the construction of the first railway, experiments were instituted for the purpose of locating the exhaust nozzle in the most efficient position, and it is well known that Stephenson owes his victory in the locomotive contest at Rainhill, in 1829, to the fact that he was the first to make an application of the exhaust nozzles to boilers for inducing a greater draft. Pambour, in 1836, was the first to institute a systematic series of experiments. He made, however, only a few, and the results that he obtained are of no great value. Nevertheless Pambour set forth the proposition that the exhaust-pipe pressure varies directly as the speed of the piston and the generation of steam per hour, and, therefore, inversely to the sectional area of the pipe itself. He considered that the pressure in the exhaust-pipe was the same as the back pressure upon the pistons, until, in 1847, it was proven by Gouin and Le Chatelier that this is not the case. Among the French engineers who busied himself with this question at that time was Polonceau. He made some special experiments with exhaust nozzles of various sizes.

Clark first threw light on these subtle relationships by means of his very important and thorough investigations which were made in 1850. They were made upon a large number of locomotives, and from them the following results were obtaiued :

1. The vacuum in the smoke-box stands in direct relationship to the pressure in the exhaust-pipe. That is, the vacuum expressed in inches of a water column gives the pressure in the exhaust-pipe in inches of mercury :

$$\frac{\text{Vacuum in smoke-box}}{\text{pressure in exhaust-pipe}} = \frac{1}{13.6}$$

or, in round numbers, $\frac{1}{14}$.

2. The draft creating properties of the exhaust is, first of all, dependent upon the form and size of the stack and the position of the nozzle. Above does the height of the exhaust opening and the diameter of the stack influence this matter.

3. With each stack there is some maximum size of exhaust nozzle that will produce the best results. For a given boiler there is only one diameter of stack that is most efficient ; and for all other diameters the nozzle must be contracted.

4. The best position for the exhaust nozzle is that from which the steam will be blown vertically into the stack. Hence the centre line of the nozzle must coincide exactly with that of the stack.

5. The products of combustion must be able to enter the stack easily, either by making the bottom bell-shaped, or, better still, by locating the exhaust opening below the top of the smoke-box by about the diameter of the stack.

The exhaust will thus be always blown through and through the products of combustion, and not merely over the top of the same. A straight, vertical exhaust-pipe is therefore greatly to be preferred to the crooked pipe that was formerly in general use, since it offers less resistance to the steam as well as to the gases in their passage to the stack.

6. The proper sectional area of the exhaust nozzle is dependent upon the grate area, the sectional area of the tubes, the diameter of the stack, and the size of the smoke-box.

The larger the grate area and the sectional area of the tubes in the fire-box tube-sheet, and the smaller the diameter of the stack and the size of the smoke-box, the larger it is possible to make the nozzle.

7. In order that a stack may work at its maximum efficiency, it must have a length that is approximately about four times its diameter.

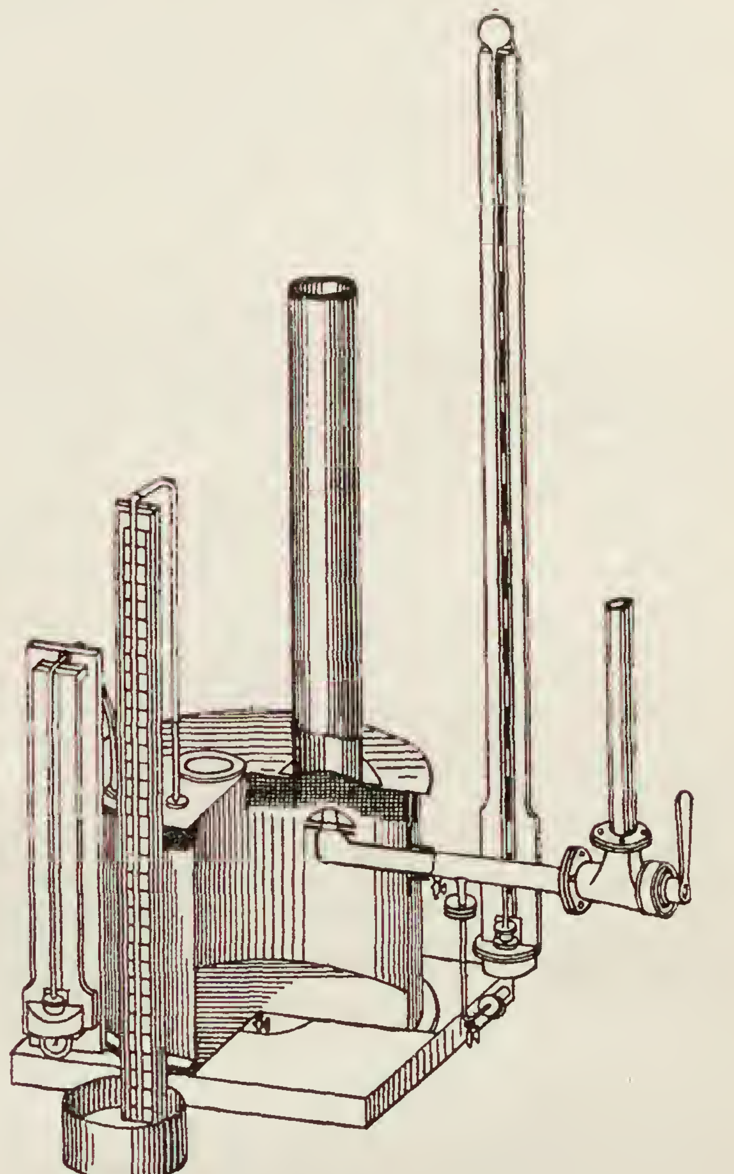


Fig. 1.

THE ZEUNER APPARATUS.

8. The smallest sectional area of stack that was observed was one-fifteenth of the grate area, and this permitted the use of a larger exhaust nozzle than any other larger stack. So that these observations are taken to indicate that this proportion (one-fifteenth) is the most efficient.

9. The exhaust nozzle may have a sectional area equal to from one-sixty-sixth to one-ninetieth of the grate area, provided that the sectional area of the tubes in the fire-box tube-sheet shall be made from one-fifth to one-tenth of the grate area.

10. The vacuum in the fire-box is from one-third to one-half of that in the smoke-box.

It should be remarked just here that the English locomotives of those days had very small grates, whose area did not average more than 12 sq. ft.; hence, Rules 9 and 10 cannot be applied to locomotives of the present day. Also, Rule 3 and the second paragraph of Rule 6, in which it is stated that the exhaust nozzle can be enlarged as the diameter of the stack is made smaller, cannot be applied in its general construction to locomotives. According to the Hanover experiments, the vacuum can be increased by making the diameter of the stack less. With this, if the original vacuum is to be retained, the nozzle may be enlarged, which will result in the lowering of the pressure in the exhaust-pipe and the back pressure upon the piston ; but, as I stated at the opening of this paper, this enlargement of the nozzle must take place between narrow limits, else the combustion will be poor and the coal consumption increased. For this reason, then, it would be inexpedient

to use that small size of stack that would permit the largest nozzle to be used.

Furthermore, my investigations have led me to the belief that it is generally desirable to use as large a stack as possible. Especially worthy of note in the Clark rules that are given above are the results 2 and 5, wherein it is asserted that the height of the nozzle has an important influence upon the action of the fire, a position that is disputed as being incorrect by some later writers. Later, during Peacock's experiments, Clark was Locomotive Superintendent of the Manchester, Sheffield & Lincolnshire Railway, and in the summer of 1850 undertook a series of experiments with locomotives, and found that by lowering the opening of the exhaust-pipe and enlarging the same he could secure a better production of steam.

In the locomotive under consideration, which had a cylindrical stack with a diameter of 18 in., and having originally a nozzle $4\frac{1}{2}$ in. in diameter that was 1 in. above the top of the smoke-box ; it was gradually dropped until it was 18 in. below the top of the smoke-box, where a nozzle with an opening of $4\frac{3}{4}$ in. gave the best results. As a result of this experiment Peacock placed all of his nozzles at this distance below the top of the smoke-box.

In Germany, Switzerland, and other countries these results seem to have been followed without any change up to the present time.

Zeuner.—Eight years after these experiments, in the summer of 1858, Zeuner began his well-known experiments upon the exhaust-pipe, which he continued during the following year, and in 1863 published his epoch-making book, "The Locomotive Exhaust-Pipe," and embraced therein his theory of its action.

Zeuner carried on his experiments in the workshops of the Zurich Railway with an especial apparatus. In order to render a comparison possible between the results obtained by various experimenters, who have made use of special apparatus, and determine the value of their deductions, it will be well to give a short description of them.

The Zeuner apparatus is shown in fig. 1. It consists essentially of a sheet-iron chamber having a diameter of 22.44 in. and a height of 17.7 in., into which the steam-pipe from the boiler projected carrying the blast nozzle at its extremity. Upon the top of this chamber the stack was placed and through it the steam with the air that had been drawn in escaped. Afterward an opening about 4 in. in diameter was made in the top for the purpose of admitting air. The steam pressure in the blast-pipe was regulated by means of a hand-cock and measured by a quicksilver gauge, while the vacuum that was induced in the chamber was also measured by a similar gauge and a water column.

The stacks, of which there were five, had clear diameters of 1.6 in., 3.2 in., 3.9 in., 4.7 in., and 5.8 in., while the blast-pipe had diameters of .39 in. and .56 in.

In the air opening for the purpose of changing its sectional area there were placed rings having clear openings of .39 in., .78 in., 1.56 in., 2.36 in., and 3.15 in. inside diameter.

From these investigations, which embraced over 2,000 measured observations with this apparatus, and from his theoretical opinions, which were the first upon this subject that were examined in so thorough a manner, Zeuner came to the following conclusions :

1. The distance x, as given in fig. 2, which is the distance of the top of the nozzle from the bottom of the stack, can be varied between tolerably wide limits, without particularly disturbing the evenness of the ratio of the vacuum existing in the chamber during the outflow of steam.

Nevertheless, adopted as the result of his investigations 1.57 in. as being the distance equal to x, at which the stream of steam could enter the different stacks with the least hindrance.

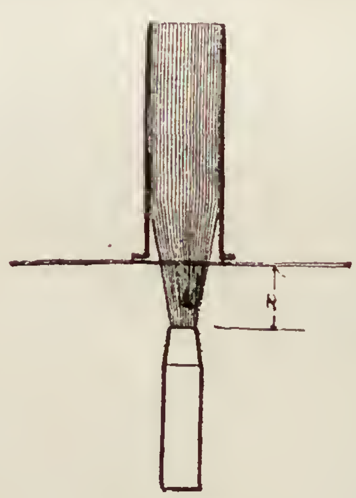


Fig. 2.

2. In general the opening of the blast-pipe must be raised and brought nearer to the mouth of the stack, as the latter is made smaller, provided the vacuum is to be kept the same. It may be possible to take the distance of the opening of the blast-pipe below the opening into the stack as equal to from one to two times the diameter of the stack that is being used.

3. In general it happens, in consequence of the friction of the steam and air in the stack, there is a marked diminution of the suction action of the stream of steam, if the length of the pipe is more than 30 times the diameter.

4. It was also observed that the position of the blast-pipe relatively to the opening into the stack, the capacity, and, in a general way, the very shape of the smoke-box of a locomotive, and, finally, the height of the stack, have all a very important influence upon the action of the exhaust. At least it may be asserted that locomotives built to-day in accordance with these directions can hardly be improved.

5. The vacuum—that is, the difference existing between the pressure in the chamber and that of the atmosphere—increases in a direct ratio with the steam pressure. It does not depend upon the absolute size of the steam opening, the air opening, and the stack, but upon the ratio existing between the first and the last, and the quotient :

$$\frac{\text{Area of steam opening}}{\text{Sectional area of stack.}}$$

6. For a given size of blast-pipe and air opening, there is always some diameter of stack, wherein the sucking action of the steam current is the greatest, and with all other diameters this action is weaker. This point of maximum efficiency leaves one in a position to define the theory of the action very sharply.

7. With the same nozzle opening and stack, the amount of air drawn in varies directly with the square root of the steam pressure.

8. The ratio existing between the vacuum in the smoke-box and the pressure in the exhaust-pipe is variable, and, with the ordinary blast-pipe arrangements, depends essentially upon the cross-section of the blast-pipe opening and a known coefficient u, indicating the resistance of the products of combustion in the tubes. If, therefore, we adopt the common acceptation of the results of Clark's experiments which have been used up to the present time, this ratio becomes one-fourteenth for locomotives, and that only an approximation and applicable, also, only to the locomotives upon which Clark conducted his investigations. On the whole, however, it appears that, when everything has been taken into consideration, this ratio can be subjected to no very great fall, provided the heating and running of the locomotive is normal.

It must be remarked just here, however, that the conclusions announced in Nos. 1, 3, 4, and 6 are not in accord with the results of the experiments carried out in the Leinhausen shops in the years from 1892 to 1894. In opposition to Zeuner, it must be said that the position of the exhaust nozzle relatively to the bottom of the stack, as well as the length of the stack, certainly does have an influence upon the working of the draft. Further, this is evidently not limited to a stack having a length equal to 30 times the diameter, but to one with a length of six diameters. Finally, that diameter of stack which showed the highest vacuum in the apparatus cannot be said to be universally the most efficient, since upon a locomotive it might act very unfavorably. We can see from the data developed by the Hanover experiments that the vacuum rises, the other conditions remaining the same as the stack is made smaller—that is, within certain defined limits, and beyond these limits it falls rapidly away. This stack, which in the apparatus gave the best draft, is too small for a locomotive, the ratio between whose grate and tube areas is based upon the dimensions of the experimental apparatus, and, consequently, would not give a proper draft to the fire nor an economical coal consumption, and so cannot be claimed to be the most economical. This brings up still another influence that will be referred to later.

That Zeuner reached the other results which he has promulgated depended upon his choice of the dimensions of his apparatus. Not only was the stack altogether too long, but it was far too large in comparison with the diameter of the blast nozzle that was used. The latter had, as we have already said, a diameter of only from .39 in. to .56 in., while the former was 1.6 in., 3.2 in., 3.9 in., 4.7 in., and 5.8 in. Hence, the diameters of these stacks were 4, 8, 10, 12, and 15 times as large as the .39 in. blast nozzle.

Now in actual locomotive practice, as well as in the recommendations of Zeuner we have nozzles varying in diameter from 3.5 in. to 5 in. Suppose we take one with a diameter of 4 in., we must, in accordance with the data given by this apparatus, have five stacks with diameters of 16 in., 32 in., 40 in., 48 in., and 60 in., sizes which naturally are wholly out of the question for practical work. Then, too, the smallest stack of the Zeuner apparatus gave values that varied from those obtained from the other four large ones, yet Zeuner disregarded it in his investigations, although it approached more nearly than any of the others to locomotive practice ; and, in addition, the vacuum was very low, giving a water column of only $1\frac{3}{8}$ in. with an excess of blast-pipe pressure of $\frac{1}{4}$ atmosphere, while in actual locomotive service it is at least double

this, with a blast-pipe pressure that is considerably lower. It is also highly probable that in the further stack experiments air was drawn in from above, as was shown to be the case in the Hanover experiments. From this point of view, also, Zeuner found a very slight difference in the vacuum, whether he conducted his experiments in an open or perfectly tight chamber, and from the same standpoint he found no marked influence due to the length of the stack, although he gradually shortened it from an original length of 4 ft. 11 in. to 14¾ in. What an important influence this variation in length does have upon the action of the exhaust is evidenced by the Hanover experiments. Although it should happen that not one of the values derived from these experiments should have a practical working value, we still have the service which the genius of Zeuner rendered in developing the theory of the blast-pipe, and for which the painstaking investigations which he carried out were necessary.

Nozo and Geoffroy.—At almost the same time with Zeuner—that is, in the fall of 1860—the French engineers Nozo and Geoffroy carried out some similar experiments, independently of Zeuner, but also with cylindrical stacks only, since up to that time no other shape was known. The apparatus used by them is illustrated in fig. 3. It was similar to the Zeuner apparatus, yet with this essential difference, that it was not cold air but the products of combustion of a locomotive which were drawn in, and that the boiler of the same supplied the steam for the experiments. The steam was led from the throttle into a special reservoir of 11.3 cub. ft. capacity, and in this, while each test was being carried out, a constant pressure was maintained, which could be accomplished by means of the throttle-valve and one on the reservoir opening into a

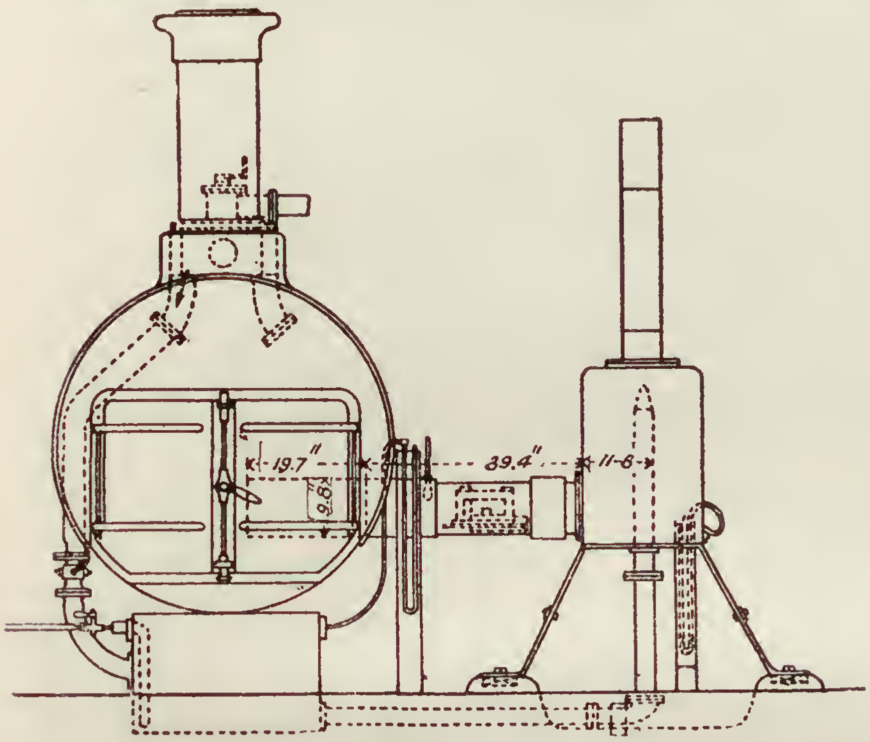


Fig. 3.
THE NOZO AND GEOFFROY APPARATUS.

waste pipe. The blast-pipe chamber also had a capacity of 11.3 cub. ft. In the pipe used for conducting the products of combustion into the chamber, an anemometer was placed which could be read through a glass-covered peep-hole. In order that the experiments might be carried on with openings for the admission of air of different sizes, false plates with holes of the same size, but varying in the number of the same, were placed in the blast chamber in front of the air-pipe. During these experiments the locomotive boiler was fitted with a stack 21 ft. 3¾ in. high, whose natural draft sufficed for the generation of the steam.

The experiments were made with four blast-pipes of .39 in., .55 in., .79 in., and 1.1 in. diameter, and 10 stacks varying in diameter from 1⅝ in. to .79 in. in diameter. The height of the latter was equal to eight times its diameter. The perforated plates had a free sectional area through holes of .35 in. diameter that varied in number from 20 to 320. The steam pressure in the receiver varied from 1 to 11½ lbs. per square inch.

Upon using a blast nozzle having a diameter of 1.6 in., a stack 5.5 in. in diameter, and a steam pressure of 2 lbs. per square inch, a vacuum equivalent to a water column of 1.7 in. would be obtained in the smoke-box of the apparatus, while the temperature of the air that had been drawn in would be about 313° F. If the steam pressure was increased threefold to 6 lbs. per square inch, a vacuum of 5.55 in. would result, and the temperature would rise to 331° F., which was about one-half the true temperature. Nozo and Geoffroy arrived at the following conclusions :

1. Each length of stack that gives the maximum results is independent of both the area of the blast nozzle and the passage for gases, but not of the steam pressure, and is but slightly independent of the diameter of the stack. It must be from six to eight times that diameter. A greater length has no influence.

2. A funnel shaped opening to the bottom of the stack seems to have no marked influence upon the draft.

3. A stack of suitable length can project down into the smoke-box to the top row of tubes without injury to the draft, if the blast nozzle is dropped at the same time ; but the draft is very seriously impaired if the lower end of the stack is plunged down into the stream of gases.

4. With a proper length of stack—that is, one varying from six to eight times the diameter—the distance of the nozzle from the stack has no marked influence so long as this distance does not exceed one and one half times the diameter of the stack ; when this is exceeded the draft is materially injured. The projecting of the nozzle into the stack seems to have no detrimental influence worth mentioning, so long as the adjustment of the nozzle is such that it is in true alignment.

5. With a given sectional area of the tubes and nozzle, and a given velocity of flow of the steam, there will be one sectional area of stack that produces the greatest draft, the length being held at from six to eight times the diameter. In the neighborhood of this area the diameter of the stack can be subjected to considerable variation, without having any very great influence upon the amount of air that will be drawn in.

6. If with the same tube area or the same resistance the nozzle be changed from double to single, the result will be according to 5, that for a given stack and velocity of steam flow the draft will be increased.

7. An ordinary stack of a given section and a single nozzle can be replaced by a multiple stack and a multiple nozzle—that is to say, a single large nozzle can be replaced by a bundle of small tubes.

To these conclusions it may be remarked that the length of stack as they found it is too great, and is doubtless to be attributed to the small dimensions of the apparatus that was used. The ratio which corresponds to the effective action, as shown by the Hanover experiments, is that, for the maximum draft, the length should be from four to five times the diameter. Furthermore, the funnel-shaped opening does have a very important influence upon the draft, since it offers free access for the gases to the current of steam.

Likewise conclusions 3 and 4 do not coincide with locomotive experience, and the same may be said of the concluding portion of No. 5. As has already been noted, Zeuner says that a stack always maintains the best draft at a given ratio. Conclusion 6 is likewise at fault, for, for each diameter of nozzle there is also only one cylindrical stack that will give the maximum draft, provided the length remains unchanged, whose diameter increases the larger the nozzle that is used with the same steam pressure.

Conclusion 7 is of no practical value for locomotive work.

Nozo and Geoffroy also conducted their experiments upon a running locomotive while it was hauling a train. In this work they used seven different stacks having diameters of 9 in., 11 in., 12.5 in., 14 in., 15.4 in., 17.7 in., and 17.8 in., whose lengths were 6 ft. 2.8 in. The nozzle had a diameter of 4.3 in. with its opening 3.9 in. below the bottom of the stack, so that the effective height of the stack was 6 ft. 6.7 in. (2 metres).

The results obtained from these experiments were as follows :

The three stacks with diameters of 9 in., 11 in., and 17.8 in. were useless, while with the other four the trip could be readily made on schedule time. The stacks with diameters of 12.5 in., 14 in., and 15.4 in. diameter gave a plentiful supply of steam. A graphical result was drawn for each stack, and these showed that the diameter of 14 in. was the best for the locomotive under consideration.

Regarding these experiments, it may be said that the action of the stack appears to be judged entirely by the amount of draft obtained ; but this construction is not the only one that should have an influence, for, in Germany at least, it is required of the stack that the fire shall not only work properly and burn quietly, but that the amount of coal that is carried from the fire-box to the smoke-box shall be as small as possible, thus cutting down the amount of sparks and cinders. It seems odd, too, to note in this report that with a stack of 17.7 in. diameter the trip was made in schedule time, while with a stack of 17.8 in. in diameter, or only .1 in. larger, the action was unsatisfactory. Here, at all events, there must have been some other circumstances at work which could not have been

known to the observers, so that the experiments of Nozo and Geoffroy are of little value for the construction and operation of locomotives of the present day.

(TO BE CONTINUED.)

HIGH-SPEED LOCOMOTIVE ON THE LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

SEVERAL years ago there was a lengthy discussion in one of the railroad papers on the possibility of a train being run from Chicago to New York in 18 hours, and many railroad men were, at that time, disposed to look upon the matter as impracticable if not impossible; but the high speeds for long runs that was first shown to be possible by the establishment of the Empire State Express in regular service after the 24-hour trains between New York and Chicago had been an accomplished fact, demonstrated that higher speeds than those to which we have been accustomed were a possibility for long runs. The Empire State Express, or the trains making the preliminary runs, held the record, we believe, until the recent race between the East and West Coast routes from London to Aberdeen transferred the record to the credit of the English roads. The possession of the record was of short duration, however, for a special train on the New York Central & Hudson River Railroad promptly wrested the prize from the English, only to lose it with equal promptness to the Lake Shore & Michigan Southern Railway in the run reported in our last issue, whereby a party, by taking advantage of the Empire State Express from Buffalo, made the passage from Chicago to New York in 17¾ hours, thus more than realizing the dreams of 10 years ago, and making this quick passage an accomplished fact.

That improvements in the road-bed and cars have contributed greatly to this achievement is beyond a question, but the main credit belongs of necessity to the locomotives. These machines are naturally of great interest, and we publish herewith a reproduction of a photograph of the engine making the fastest time over a division on the recent Lake Shore run. It is of the 10-wheeled type, and, by its performances, has demonstrated that the six-coupled engine is a reliable high speed machine, and it will only remain to duplicate the trip, using a mogul, in order to wipe away the last prejudice against the pony truck for fast work.

The following is a list of some of the principal dimensions of this locomotive, which was built for the railroad company by the Brooks Locomotive Works, of Dunkirk, N. Y.:

GENERAL DESCRIPTION.

Gauge	4 ft. 8½ in.
Fuel	Bituminous coal.
Cylinders	17 in. diam.; 24 in. stroke.
Driving wheels	68 in. diameter.
Rigid driving-wheel base	8 ft. 6 in.
Total " "	15 ft.
" wheel base of engine	25 ft. 3 in.
" " " " " and tender	48 ft. 8 in.
Weight of engine in working order	113,500 lbs.
" " " on engine truck	25,000 lbs.
" " " " drivers	88,500 lbs.
" " tender, loaded	78,000 lbs.

BOILER.

Type	Crown-bar wagon-top
Working pressure	180 lbs.
Material	Steel, $\frac{9}{16}$ in., ½ in., $\frac{7}{16}$ in.
Riveting	Longitudinal seams, quadruple lap, without welt.
"	Circumferential seams, double lap.
Waist diameter at smoke-box	52 in.
Tubes	202 in number, 2 in. diam. charcoal iron.
"	Length, 13 ft. 10 in.
Fire-box	96 in. × 42 in., inside ring.
" depth	64 in. at front end, 50 in. at back end.
" crown sheet	Arched 1½ in. laterally in centre.
Brick arch	Carried on three 3½ in. water tubes.
Heating surface, fire-box and arch pipes	145 sq. ft.
" " tubes	1,462 sq. ft.
" " total	1,603 sq. ft.
Grate area	28 sq. ft.
Tube opening	3.6 sq. ft.
Safety valves	1 Richardson muffled and 1 Richardson plain.
Extension front	Deflector in front ef exhaust pipe.
Stack	Cast-iron straight 16 in. diam.
Exhaust pipe	High double.
Grates	Cast iron rocking bar.

MACHINERY.

Cylinders	17 in. × 24 in, 84 in. centres.
Cylinder packing	Dunbar
Valves	Brooks Locomotive Works, Allen Richardson.
" lap outside	1 in.
" " inside	$\frac{3}{32}$ in.
" lead in full gear	$\frac{1}{64}$ in.
Valve travel, maximum	6⅛ in.
Driving-wheels, diameter	68 in.
" centres, diameter	62 in.
" tires, Midvale	With Mansell retaining rings.
Driving axles	Hammered iron.
" " journals	7½ in. × 9 in.
Engine truck, four-wheeled	Swivelling centre.
" " wheels	33 in. Allen paper.
Engine truck axles	Hammered iron.
" " " journals	5 in. × 10 in.
Feed water	Two No. 8 Monitor injectors.
Brakes, train, and tender	Westinghouse.
" drivers	"
Train signal	"

TENDER.

Frame	10 in. Channel steel.
Tank	$\frac{3}{16}$ in. and ¼ in. steel.
" capacity, water	3,700 galls.
" " coal	6 tons.
Tender trucks	Diamond pattern.
" " bolster	Steel I beam.
" " wheels	36 in. Allen paper.
" " axle	Hammered iron.
" " " journal	4 in. × 7 in.

This locomotive hauled the train over the division extending from Erie to Buffalo, and, as reported in our last issue, it was here that the fastest time between Chicago and Buffalo was made, showing at one point a speed of 96 miles per hour. The following is a detailed schedule of the run by stations:

Miles.			Miles per Hour.
	Left Erie,	10.20 A.M.	
11	" Moorhead,	10.32 "	55
4	" North East,	10.35 "	80
4.8	" State Line,	10.38 "	96
10.7	" Westfield,	10.47 "	71.3
8.1	" Brocton,	10.52 "	97.2
9.1	" Dunkirk,	10.59 "	78
12.7	" Irving,	11.09 "	76.2
2.0	" Farnham,	11.10½ A.M.	80
4.1	" Angola,	11.14½ "	61.5
12.3	" Athol Springs,	11.25 "	70.2
7.2	" Buffalo Creek,	11.31 "	72
2	" Buffalo Depot,	11.34 "	40

86 miles to Buffalo Creek.
88 " " " Depot.

Average speed per hour, Cleveland, O., to Buffalo Creek, N. Y. .68.73 miles
" " " " Erie, Pa., to Buffalo Creek, N. Y .....72.67 "
" " " " " " " Dunkirk, N. Y.............73.4 "
Maximum speed, 96 miles per hour.

In connection with this engine, which is, we believe, the first 10-wheeler to make such exceedingly fast time, it will be interesting to make a comparison with the locomotives making the fast time on the recent London-Aberdeen race.

The Great Northern locomotive hauling the East Coast express over the first division of the line from London to Grantham had a single pair of drivers 8 ft. in diameter and cylinders 19½ in. in diameter, with a stroke of 28 in. The average time for the 105 miles was 55.8 miles per hour, with a speed of 62.5 miles for one stretch of 59 miles of the distance. These engines are similar in design to those used on the Royal Blue Line from Jersey City to Philadelphia. There is a four-wheeled bogie truck forward and a trailing two-wheeled truck back of the fire-box and rigid with the frame. The cylinders are outside the frame and the boiler in between the wheels, with its centre below the tops of the latter. Over the second division of the Great Northern, from Grantham to York, a similar engine was used, except that the drivers were 7 ft. 6 in. in diameter and the cylinders 18⅞ in. in diameter, with a piston stroke of 26 in. From York to Newcastle, on the Northeastern the train was still hauled by an engine with a single pair of drivers 7 ft. 6 in. in diameter, with cylinders 19 in. in diameter and 24 in. stroke of piston.

From Newcastle to Edinburgh the Northeastern engines were eight-wheeled (four wheels coupled) inside connected, with 7 ft. drivers and cylinders 19 in. in diameter and 26 in. stroke. A similar engine was used on the North British Line on the run from Edinburgh to Aberdeen, except that this engine had the smallest cylinders and drivers of any engine on the run. The former were 18 in. in diameter, with a piston stroke of 26 in., and the drivers were 6 ft. 6 in. in diameter. It will be seen, then, that this Lake Shore locomotive had smaller drivers than any of the English engines, as well as being smaller than the well-known No. 999 of the New York Central & Hudson River Railroad. Taking the highest rate of speed attained by this engine of 96 miles per hour, we find that the piston speed was 1900 ft. per minute. It shows, too, that the attainment of high speeds is not necessarily dependent upon the use of drivers of large diameters, though that may be a very desirable property for the locomotive to possess.

THE VENTILATION OF THE BOILER-ROOM.

ONE of the weak points of steam service at sea is the high temperature of what is known sometimes by the significant name of the "stoke hole." The exhausting character of the work there seems to be intensified by the progressive changes incident to the development of great ships and high motive power, and not only in tropical seas, but even on the North

Atlantic firemen have not infrequently become so affected by the heat as to throw themselves overboard, or attempt to do so, as happened a week or two since on one of the great liners of the weekly Atlantic service. In war vessels the heat of the fire-room is likely to become insupportable at precisely those times when it may endanger the safety of the ship or diminish her fighting powers. Commander McGiffin, to whom we owe so many valuable notes on the practical conditions of modern marine warfare, has pointed out the terrible condition of his firemen in the Yalu fight, when the temperature of the fire-room rose to such a point that men were blinded permanently by its effects.

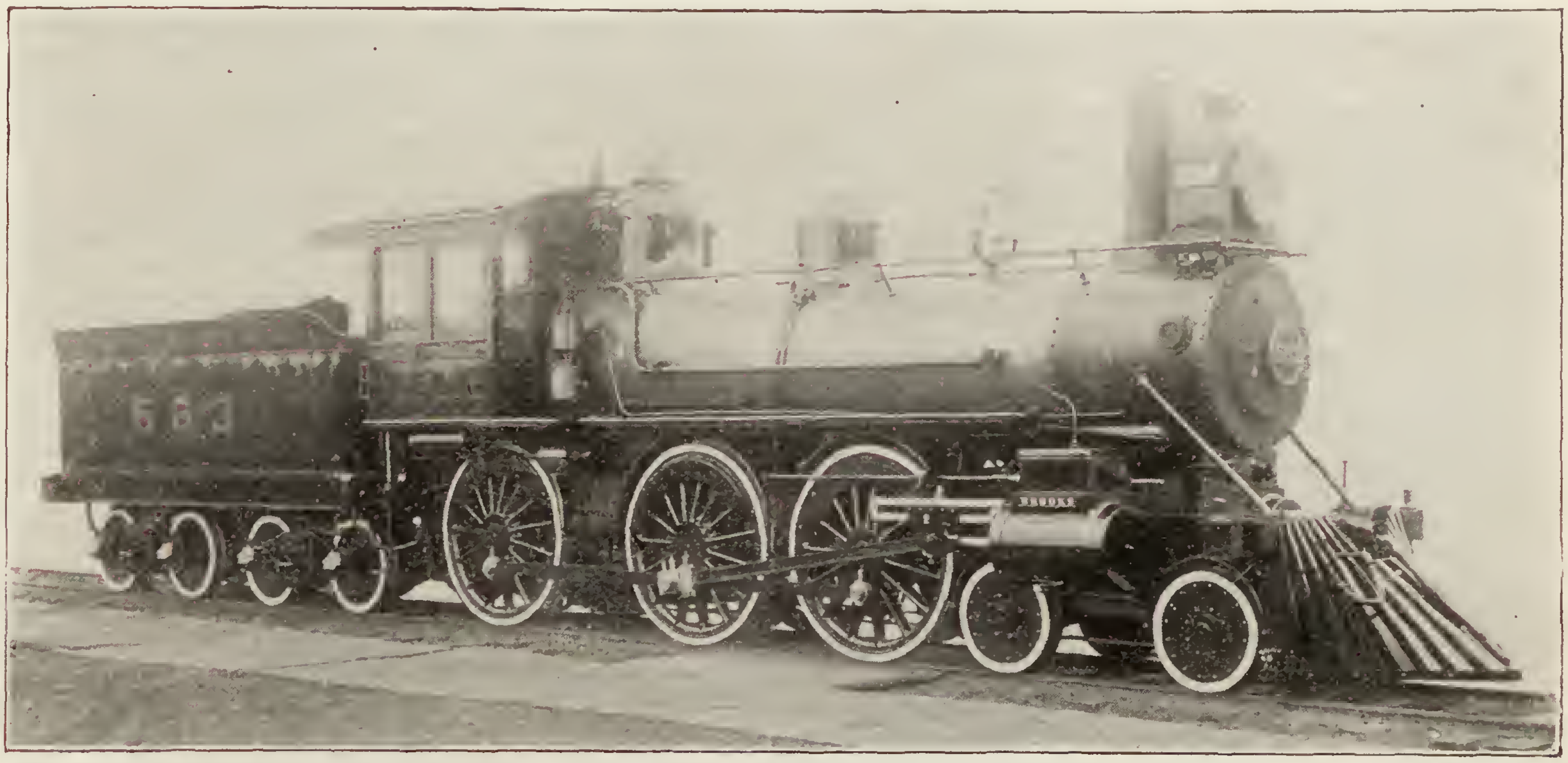
The importance of the subject has been recognized from the first, and devices for improving the condition of the firemen have been discussed most anxiously, but it is safe to say that no navy in the world has attained anything like efficiency in this important branch of the ship's hygiene. We shall not, therefore, be considered presumptuous if we point out that there is only one method by which the human frame can be made to support active labor in high heat, a method based upon the unchangeable laws of nature.

The fundamental principle which must underlie any successful device of this kind is that the body must be made its own refrigerator, and there is but one mode of applying this principle—a stream of comparatively dry air must be so directed upon the man's body that his perspiration will be vaporized rapidly and the refrigerating effects of evaporation produced. The body should be as nearly nude as the strong radiation from the furnace will permit, and the men should drink freely, preferably of cool barley water.

The change from the existing system which we propose is radical. At present the method of ventilation employed may be called the room method, as opposed to the method of individual refrigeration. A large quantity of air is thrown into the boiler-room with the intention of establishing there an atmosphere in which the men can work. It does not appear that the quality of this air has received much attention, though it is useless to bathe perspiring men in an atmosphere already loaded to the maximum with moisture. It is not only the method of ventilation that must be changed, but its uses, for the whole object of ventilation in the presence of great heat is to cool the man's skin and not his lungs, and for the former use cold air is not only useless, but detrimental. We have spoken of "comparatively dry air," and air is of this kind when it possesses the power of absorbing moisture. This power is a function of temperature, and may be given to moist air, like that of the ocean, by warming it and raising its capacity for humidity ; but the present system fails entirely in this respect.

We think it will be found that the air thrown upon the firemen should have nearly the temperature which the fire-room naturally takes from the furnaces. One hundred degrees Fahrenheit is by no means an exhausting or even a difficult temperature to work in. Men by thousands have sustained that heat and much more than that in this country, not for short periods, but for eight hours a day, 28 days in the month, and year after year. We know of one instance where men were working in a temperature of 112° F. Air was taken from a point where the temperature was 88° and driven by a rudely made fan through a galvanized-iron pipe, in which its temperature rose to 108°, the pipe being so disposed that it pointed straight for the men who were working, stripped to the waist, about 15 ft. away. The fan must have had a very low efficiency, perhaps not more than 30 or 40 per cent. ; but when the steam was turned on a little and the fan ran faster one of the men came back saying it was cold, and turned down the steam. In other cases of successful ventilation of working men the respective temperature of working place and air supply were 98° and 96°, 112° and 109°, 114° and 114°, 112° and 111°, and others much higher could be adduced.

These temperatures are comparable to those which obtain in steamer boiler-rooms under ordinary conditions ; and it would be possible to show that the higher temperatures in tropical climates or under unfavorable conditions are not greater than those which have been met successfully on land. The following data from the French corvette *Ariadne* are old, but they are sufficiently representative. We give Fahrenheit reading :



TEN-WHEELED LOCOMOTIVE, BUILT BY THE BROOKS LOCOMOTIVE WORKS FOR HIGH-SPEED SERVICE ON THE LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

Month.	Locality.	Temperature.		
		Engine-Room.	Boiler-Room.	Coal Bunkers.
October	German Ocean	79	136	..
"	Atlantic Ocean	98	125	....
"	Mediterranean Sea	104	138	...
November	Red Sea	122	153	104
"	Indian Ocean	109	147	....
"	Straits of Malacca	115	156	....
January	Manila	118	149	109
"	Chinese Sea	80	122	80
April	" "	105	115	86
July	" "	113	147	95
September	Red Sea	93	143	91
"	Port Said	100	154	86
"	Mediterranean	94	143	90
"	"	97	138	88

The difference between the coal bunkers and the boiler room varied from 39° to 68°, the latter being at Port Said, when the ship was probably at anchor. The ventilation was entirely by deck funnels. As to the readings recorded, it is doubtful if the observations can be accepted without question, as the thermometers may have been exposed to direct radiation from the furnaces or hung against heated walls. It is noticeable that the boiler-room was as hot in the German Ocean as in the Mediterranean and Chinese seas, and if its high temperature is dependent on artificial conditions, it can be controlled by artificial means. The readings given for the coal bunkers indicate that the temperature of the atmosphere was not too great, even in the Red Sea, for successful ventilation and refrigeration.

Starting from the premise that at sea the humidity ratio is high, the system of individual refrigeration would include three essential requirements, (1) air warmed in a close con-

duit where it receives no moisture ; (2) projection of this air with its capacity for moisture thus raised directly upon the firemen ; (3) the free use of water to produce perspiration, which by its prompt evaporation in the eagerly absorbing warm air current will cool the man's body according to well-known laws.

This system probably involves the use of artificial ventilation, but that is always present or provided for in ships of war, and always in use at critical periods, such as a fight. Whether it is possible to apply it to deck ventilation is a question that probably depends upon constructive details of each ship. That the current from the funnels can be warmed and thus improved in quality is probably true, and it is also true that this warming would increase the men's comfort instead of decreasing it.

These are questions of application with which engineers must grapple. Our part is done in pointing out that there is a scientific method by which the ventilation of boiler-rooms can be lifted out of its present condition of hideous inefficiency, and that it is a method which is certainly applicable under the critical conditions of battle. It deserves the attention of naval engineers.

The unscientific notions which have governed the action even of distinguished engineers on this subject may be illustrated by the following history : in cutting one of the long Swiss tunnels the men suffered severely from heat, through the temperature, about 80°, was not to be compared to that in the fire-room of a modern steamship. Two efforts were made for their relief. In the first cars of ice were run into the tunnel, with the result of increasing the discomfort of the men by the heightened humidity of the air. With this experience an opposite method was tried, and cars loaded with unslaked lime were run in, the object being to remove the objectionable humidity ; but the heat produced was insupportable. In this country perfect success has been obtained and men enabled to work steadily in much higher temperatures by the simple device of preheating the air supply, and projecting it directly upon the men's bodies.—*Army and Navy Journal.*

THE BREAKAGE OF A LOCOMOTIVE DRIVING-AXLE ON THE GREAT NORTHERN RAILWAY OF ENGLAND.*

At eight o'clock on the morning of February 28, 1895, as a train of empty coaches belonging to the North London Railway Company was passing through the facing junction between the (Great Northern Railway) down slow and down Enfield lines at Woodgreen, the leading axle of the engine broke inside the boss of the right-hand wheel. The train did not leave the rails, but the right-hand corner of the engine frame struck the south end of the ramp of the down island platform, and sliding up it caused the engine to turn over on to its left side across the down goods and down Enfield lines.

Driver Charles Floyd and fireman Edward Cowland were both thrown under the engine when it fell over, and instantly crushed to death ; and guard Patrick Delaney, who was in the front brake van, was thrown down in his van and bruised.

The train consisted of an eight-wheeled tank passenger engine, No. 109 (with leading bogie and four wheels coupled), and 12 coaches, including two brake vans, one at each end of the train. The engine, which was running bunker foremost at the time of the accident, weighed 49 tons 13 cwt., the weight being distributed as follows : on the bogie, 14 tons, 8 cwt. ; on the driving-wheels, 18 tons ; and on the trailing wheels, 17 tons 5 cwt. The train was fitted throughout with the continuous brake. The engine had its foremost (*i.e.*, its proper trailing) axle broken in two places, its coupling-rods fractured, and bogie frame, tanks, and frame, etc., much damaged.

From an examination of the testimony given at the inquiry it is impossible to come to any other conclusion than that the accident was due to the fracture of the foremost axle of the engine, which, as the engine was running bunker first, was the proper trailing axle.

The fracture occurred in the wheel seat close to the collar, which separates the journal from the wheel seat just inside the boss of the right-hand wheel. The appearance of the axle after the accident denoted that there had been a previously existing fracture at this place, extending over about one-quarter of the sectional area of the axle. This previous fracture was apparently fairly recent, but it was clearly anterior to February 28.

Regarding this axle, the breaking of which was the cause of the disaster, it will be seen from the evidence of Mr. Pryce, the Locomotive Superintendent of the North London Railway, that the axle, which was of steel, was 25½ years old, and had run 578,020 miles. It had been under more than one engine, and it was transferred to engine No. 109 in November, 1887, the engine itself having been rebuilt in 1886. In 1889 new tires were fixed on the wheels, and in December, 1892, and in October, 1894, the engine went to the shops at Bow for repairs and for the turning up of the tires of the wheels. On all these occasions—viz., in 1887, 1889, 1892 and 1894—the axle was examined with a view to detecting any flaw that might exist, but no defect was discovered.

The examination on such occasions takes place after the axle has been removed from under the engine. It is carefully cleaned and placed in the lathe, and after it has been exposed to the vibration produced by the cutting tool during the process of turning up the wheels, the surface of it is closely examined with a magnifying-glass. Should it not be necessary for the tires to be turned up, similar vibration can be set up by striking the wheels and axle a heavy blow, or by rolling them along rails and causing them to collide with another pair of wheels or other obstacle, or in some such manner. The effect of the vibration produced by any of the above methods is to cause the oil which has penetrated into the flaw to appear on the surface of the axle in a fine black line, which can be easily detected by the eye with the help, if necessary, of a magnifying-glass.

On February 27—*i.e.*, the day before the accident occurred—the engine was in shed all day for washing out, and engine examiner James Ridgeway examined the wheels and axles, in accordance with his duty, so far as it was possible for him to do so under the circumstances, and with the means at his disposal. All he could do was to tap the wheels and axels with a hand hammer and examine by eye such portions as are visible. Such examination must necessarily be very incomplete, as the journals are concealed and only the centre portion or body of the axle is visible. Moreover, tapping the axle with a hand hammer while the great weight of the engine is resting upon it would probably not set up sufficient vibration to enable a flaw to be detected in it either by sound, or in the manner already described, even where the surface of the axle is visible. As regards the tires of wheels the case is different. A tire is shrunk on to its wheel, but is distinct from it, and a broken tire can be detected by the sound given out by it when tapped with a hammer, even when the weight of the engine is resting on it. At any rate, Ridgeway seems to have made the usual examination of the axles of engine No. 109 on February 27, and so far as he could ascertain, they all appeared to be sound. There can, however, be no doubt whatever that the previously existing partial fracture, which was discovered in the broken axle after the accident, existed on February 27, and was probably at least a month old. But no examination of the axle, such as described above, whether in the workshops or in the shed, and whether the axle was under the engine or not, would disclose a fracture or flaw situated as this was within the boss of the wheel.

Locomotive axles when new are, according to the modern practice of large companies, subjected to tests for tensile strength, ductility, and also to chemical analysis. Some companies also make use of the "drop test"—that is to say, the axles must be capable of sustaining without fracture a certain number of blows from a heavy weight (2,000 lbs. to 3,000 lbs.) falling from a height of 20 ft. or more, the axle being supported in bearings 3½ ft. apart. For these purposes it is usual, when the axles are supplied by contract, for the contractor to provide at his own expense one additional axle in every 50 supplied, and the company's inspector selects and tests any axles he may think proper out of the 51. The axles tested are held to represent correctly the quality of the casts from which they are made. Where practicable, the 50 axles represented by the axle tested are to be made from the same cast of metal. In the case of a less number than 50 axles being ordered or made from the same cast, an end is left on one axle from each ingot, from which test pieces may be cut.

Each company has its own specification as to these tests, but there is not much difference between them. Each axle has a number and the date of its manufacture stamped upon it, and a special register is kept in which are recorded the results of the tests and of the subsequent examinations to which each axle has been subjected.

As regards the examination of old axles, the method adopted by all railway companies is practically the same as that already described. Whenever an engine or tender is lifted, the bearings of each axle are well cleaned, and the journals and other parts subjected to a very careful examination, in the manner already explained, with the view of ascertaining whether there is any indication of a flaw in the material or any other defect. Should anything of the kind, however slight, be discovered, the axle is at once removed.

* Abstract of a report to the Railway Department of the Board of Trade.

In respect of the testing of new axles and the examination of old axles, the practice on the North London Railway is, it is said, similar in all particulars to that adopted by other railway companies, but there is no definite record to show what tests were made 25½ years ago, though it is believed that they were similar to those now in force.

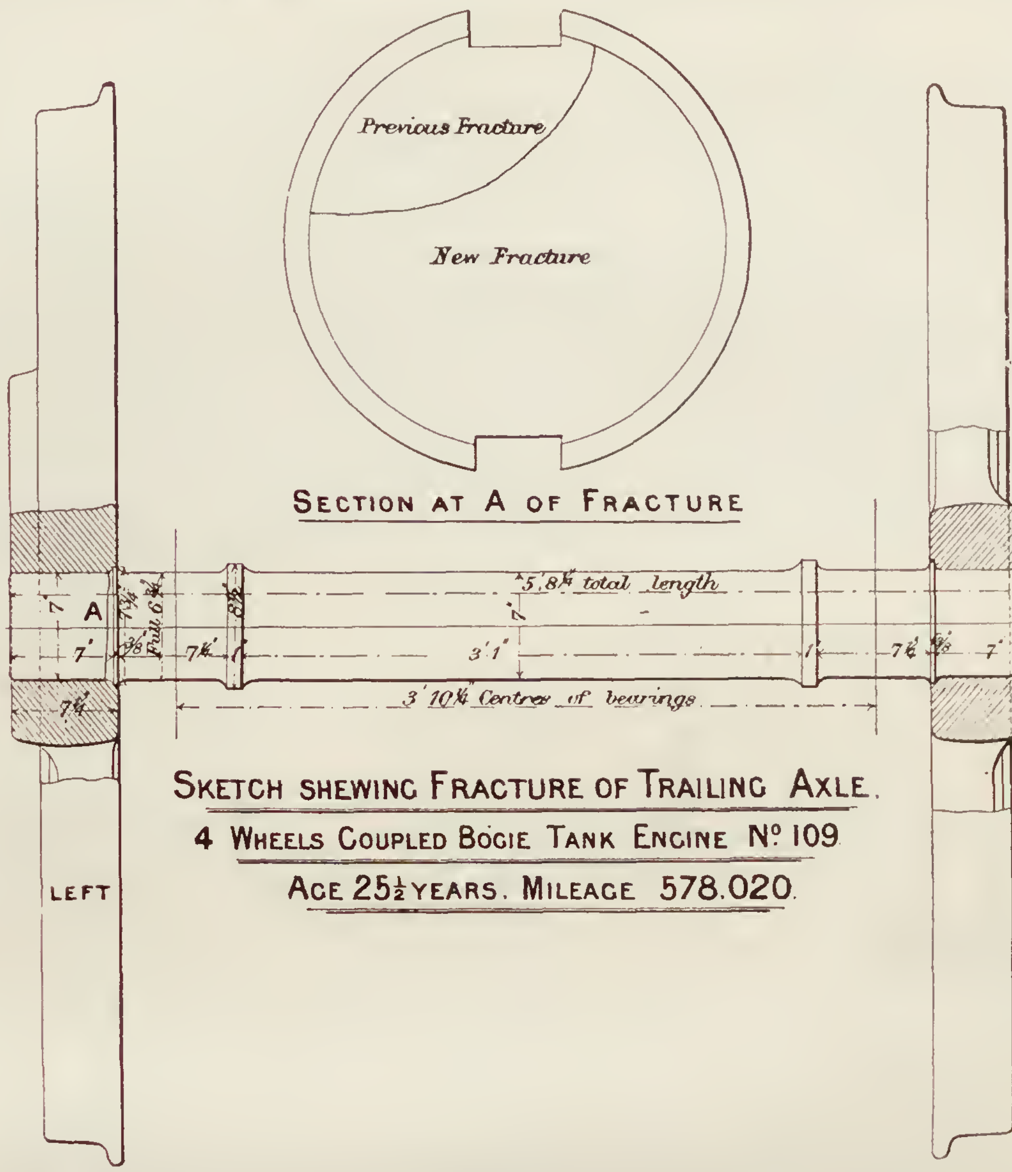
Inquiries have been made from several of the leading railway companies in the kingdom, and by the permission of the locomotive superintendents of the Northwestern and Great Western companies the locomotive works at Crewe and Swindon were visited, so as to learn the methods adopted for the testing of new axles and the examination of old axles, and it is impossible to discover that there is any practicable test at present known which will disclose a flaw in that portion of a locomotive axle which is within the boss of its wheel, and therefore concealed from view.

Doubtless the mileage run by the broken axle is high, but no limit of age either in years or miles has ever been laid down for locomotive axles, though it is usual to subject all engines to a special examination when they have run 250,000 miles, and after every subsequent 100,000 miles. This examination, which is identical with that already described, occurs as a fact on the North London Railway and on most other lines at much shorter intervals, for it is made whenever the tires require to be turned up, which probably takes place after each 40,000 to 60,000 miles run by the engine. And this was the case with the axle that broke on February 28. Its average yearly mileage was about 23,000 miles, and it was examined as stated in 1887, 1889, 1892 and 1894—that is to say, at intervals of two to three years, or of 46,000 to 69,000 miles.

The fractured surface had a crystalline appearance, and there can, I think, be little doubt that both the previous (partial) fracture and the complete fracture of February 28 were due to age combined with the effects of the severe frost.

Taking all the above circumstances into consideration, it is evident that no blame can be attributed to any servants of either the Great Northern or the North London Railway companies in connection with this lamentable accident.

It must be admitted that it is somewhat disappointing to find that science has hitherto failed to discover some practical means of testing masses of metal, such as railway axles, for flaws that are concealed from view. The present tests for new axles are extremely valuable, so far as they indicate that the quality of the metal from which a number of axles (perhaps 50) have been made is up to specification and of the highest class, but they do not prove that the whole of the remaining axles, of which the one tested is a sample, are perfect in their manufacture and absolutely free from flaws or defects. And the subsequent examination of axles when taken from under their engines is purely superficial and only capable of detecting flaws which reach the surface, and are not concealed from view.



SKETCH SHEWING FRACTURE OF TRAILING AXLE.
4 WHEELS COUPLED BOGIE TANK ENGINE Nº 109
AGE 25½ YEARS. MILEAGE 578.020.

What seems to be required is some test—possibly by means of electricity, magnetism, or sound—which could be readily applied at suitable intervals to each individual axle, and by which it can be ascertained whether the axle is structurally perfect throughout. Whether such a test is possible no one can say; but the subject seems to be one which is worthy of consideration and of more scientific investigation (as distinguished from the rougher methods of the workshop) than, so far as can be ascertained, it has hitherto received.

It has sometimes been suggested that it is desirable to fix a limit of age, either in years or miles, for all locomotive axles, after reaching which, whether they are apparently sound or not, they should be withdrawn from use. But the locomotive superintendents of railway companies have not as yet seen their way to act upon this suggestion.

It is right to mention that it is now the custom of all the companies with whom communications have been held, including the North London Company, to make the wheel-seat of every axle slightly larger in diameter than the journal and body. In this way the strongest part of the axle is that inside the wheel, and failure of an axle in the wheel-seat is consequently nowadays extremely rare. This modern form of design was not adopted in the axle which led up to the disaster under consideration, and it will be seen from the drawing that the diameter of the wheel-seat was the same as that of the journal and body.

THE FIRST STEAM LOCOMOTIVE.

SEEING what an interest is taken in the locomotive by the readers of this journal, it occurred to the writer that some particulars concerning the first practical engine of this kind would be interesting; though, of course, students and others professionally interested may have gathered these particulars before.

It is to Richard Trevithick that credit and honor are due for constructing the first practical locomotive, an engine that was put to practical use and did serviceable work for some time. This was prior to George Stephenson's famous *Rocket* by nearly thirty years, the date of this first engine being 1802. Between this and the advent of Stephenson's invention, Trevithick made two or three others, all practical, one of which was run in an enclosed space near Euston Square, London, as a public exhibition. This was in 1808; but it is recorded to have created so little interest that the shillings taken at the turnstiles did not pay the daily expenses. This latter was run on lines; the earlier ones were not

Trevithick and Watt were engaged at about the same period in inventing and improving on the stationary type of steam engine; but doubtless Watt was the most ingenious, if not the more clever of the two. Where, however, Trevithick excelled and distanced his rival was in proving the efficacy and real value of steam at high pressures. It was this that made the locomotive a possibility, and in the engine as Trevithick made it many of Watt's ideas were swept away. We all know the high value of these latter even at the present day, and it says much for Trevithick's boldness when he put forward an idea for an engine that gave good practical results without them.

At the time named the utility of the condenser, the necessity of the parallel motion, the aid afforded by the vacuum, etc., were so pronounced that to suggest the erection of an engine without them, yet capable of doing greater service, must have seemed foolish.

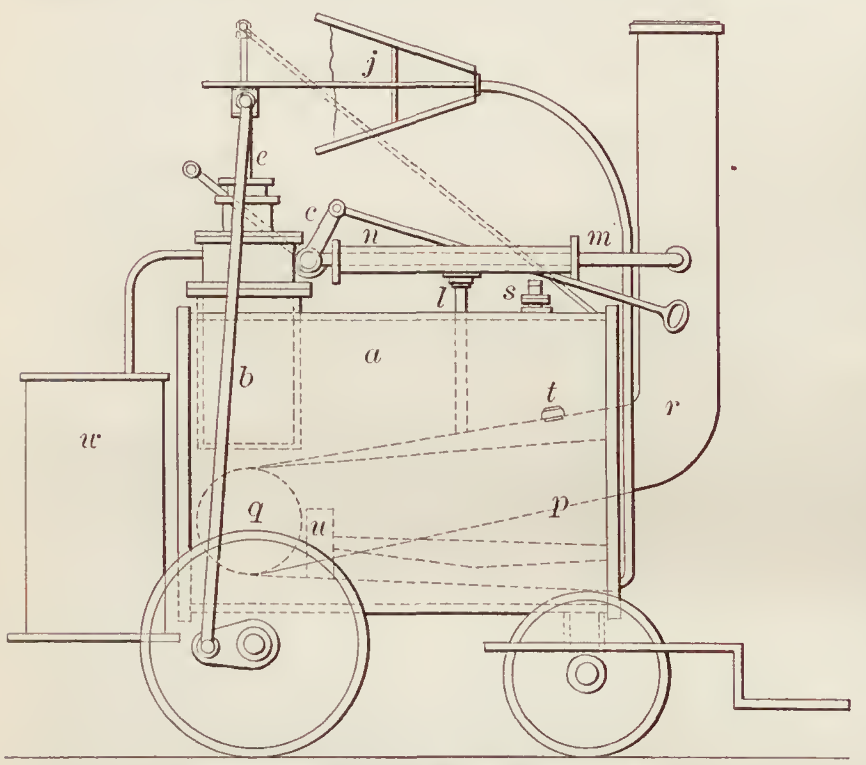
It was the use of steam at high pressures—that is considerably exceeding atmospheric pressure—that made this possible, and it is to be rather wondered at that Watt, with his splendid ideas as a mechanical engineer, did not see it. Instead of this,

he is said to have been a somewhat bitter opponent to the system and its promoter as long as he lived.

The illustration given is of the 1802 engine, which was known as the "Camborne common-road locomotive." No original drawing or complete representation has been handed down to us, this illustration being made up from details and particulars from different sources, and is pronounced, by the compilers of Trevithick's biography, to be correct.

The boiler-shell of this engine *a* was a cast-iron cylinder, with wrought-iron ends. The furnace consisted of a tubular space running from one end to the other, as shown, much resembling the furnace of what is now known as a Cornish boiler. At the end of the furnace bars furthest from the fire door, a bridge, marked *u* in the drawing, was placed, and just beyond this, where marked *q*, the flue took an abrupt turn, coming back to a position beside the fire-door and terminating in the funnel *r*. The furnace is marked *p* just by the fire-door entrance. This was an ingenious method of utilizing a short boiler to advantage, and the gradual reduction in the area of the flue-way insured better flame contact. The multitubular boiler had not been adopted at this time.

The steam cylinder *b* was immersed in the boiler, reaching down very nearly to the furnace tube. This amounted to giving the cylinder a steam jacket, at the same time rendering the engine very compact, as will be seen. Only one cylinder, with its necessary piston, was used, and the piston-rod carried a cross-arm up and down, this arm being connected with the cranks of the driving-wheels on each side by connecting-rods as shown. Steam was admitted to both sides of the piston alternately; but this single piston necessitated the cranks on the driving-wheels being precisely opposite one another whatever their position was, and this gave "dead points" in their worst form. In his next engine he overcame this difficulty by using a fly wheel driven by a horizontal piston-rod.



THE FIRST STEAM LOCOMOTIVE.

This engine was worked at a steam pressure of 60 lbs. to the square inch, and without a load was capable of making a comparatively fair speed. With a load of about 20 tons it travelled much about the speed our agricultural traction engines now do over indifferent roads, having sharp curves and steep inclines. There was a doubt at first whether the weight of the engine would cause the wheels to firmly grip the road, and the original patent provided for claws or similar devices to insure this if necessary. The "claws," however, were not called into use, though nothing would have been lost by using them, as is evidenced by the diagonal strips on the broad faces of our present-day road-engine wheels. This engine illustrated was never run on rails, consequently means had to be provided to guide it. This was effected by pivoting the smaller pair of wheels, and a handle admitted of the driver operating them.

The water-level in the boiler was kept up by a pump worked by the same cross-arm that worked the connecting-rods to the cranks. The pump is not shown in the illustration; but it was situated beside the upper part of the steam cylinder, and its rod worked in a line and parallel with the piston-rod. It drew its supply of water from the vessel *w* by the curved pipe shown, and discharged it into the boiler through the pipe *l*. An important part, however, was played by the case *n*, which, between the two flanges shown, enveloped the exhaust steam pipe. The feed water entered this case before passing into the boiler, and the consequence was that it became heated by the pipe within. In other words, it was a very creditable feed-water heater.

There has always been something of a controversy as to who originated the idea of discharging the exhaust steam into the funnel. The effect of this, in keeping the fire in its necessary bright and active state, is well known; but the credit of the invention is commonly given to Stephenson, who, with this and a multitubular boiler, made his *Rocket* of greater efficacy than all its competitors. The details of Trevithick's first engine, however, include this important feature, the pipe *m* conveying the exhaust steam from the cylinder to chimney, as shown; a four-way cock at *c*, "worked by tappets," admitting of steam ingress or egress. If this was so, then the question might be asked, Why were the bellows *j* provided? They were worked by the rising and falling piston-rod, and discharged air beneath the fire bars to keep the fuel in an active state of combustion. Trevithick's biographer suggests that the exhaust was not terminated in the chimney in a manner to have an efficient effect, but that this was recognized and overcome in his later engines. Certainly the illustrations of his other locomotives do not include any bellows, and there is little reason to doubt that Trevithick perfected the idea. To insure safety in working, a safety-velve, of the weighted-lever kind, was fixed at *s*, and a soft metal plug (a fusible plug) was put in the crown of the flue at *t*.

Trevithick's genius was undoubtedly of a very high order, for, previous to the locomotive, he was one of the best-known pioneers of the stationary steam engine. He is supposed to have been the first to put tubes in his boilers, cross tubes, which the flame and heat impinged against, greatly improving results. He did not, however, make the tubular boiler which has the flame passing through the tubes. He is also credited by his biographer with inventing the compound engine, in which he, of course, caused the steam from his primary cylinder to pass to a second, and thus do further work before being exhausted. The compound engine and the locomotive could never have been perfected as they are now, even if they could have existed at all, without high pressure steam. This was undoubtedly the greatest invention, in point of subsequent importance and utility, ever made. It is one of the things that even now is becoming of more and greater importance, and which it would be hopeless our attempting to do without. It is strange, however, that, except to a comparative few, Trevithick's name is quite unknown to fame in connection with the steam-engine. Watt's and Stephenson's names have lived, and very rightly, too; but the other man may be just as rightly ranked as equal with them.—*English Mechanic.*

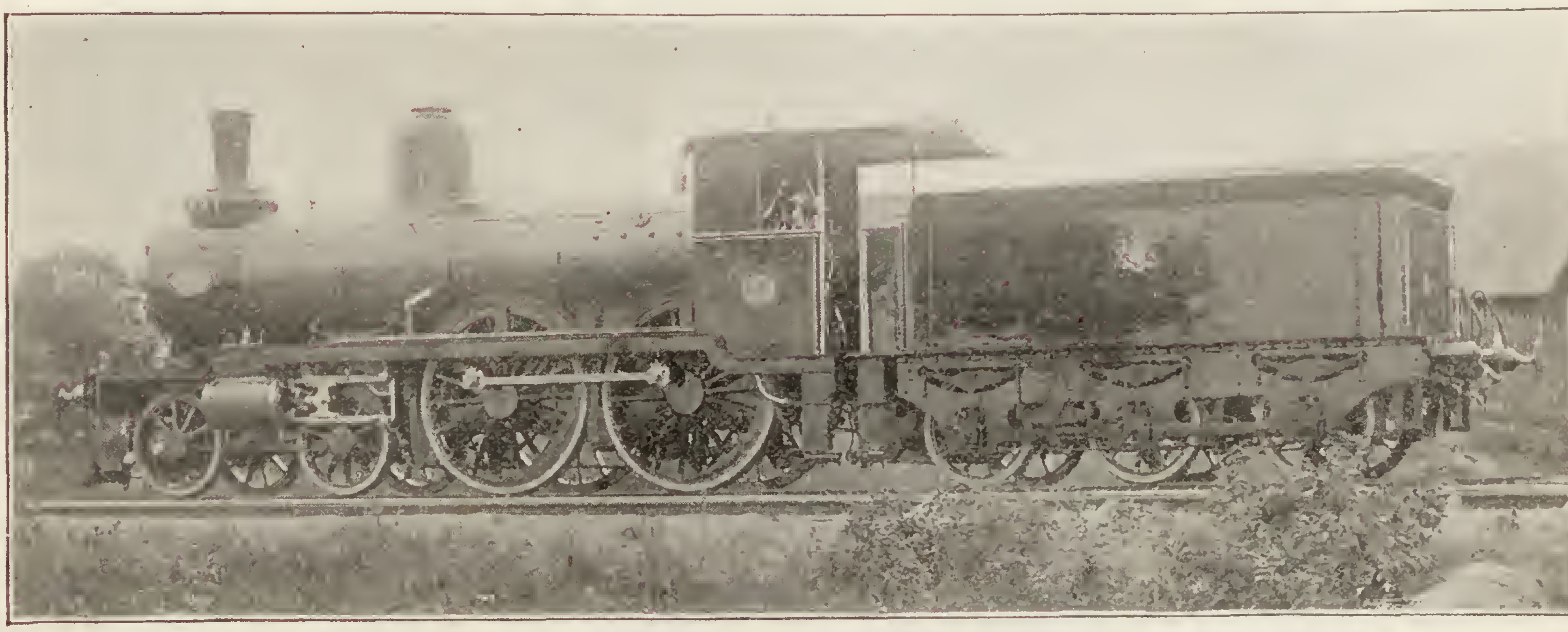
EIGHT-WHEELED PASSENGER LOCOMOTIVE FOR THE ROYAL SWEDISH STATE RAILROAD.

The eight-wheeled passenger locomotive for the Royal Swedish State Railroad, of which we give very complete engravings, might be run upon almost any railroad of the United States and attract hardly a passing notice from the average observer, though there are some distinctive features to the machine in which it differs from the American locomotive. The most characteristic feature is to be found in the location of the reverse lever and the throttle-valve, which are so placed that the position of the engineer is upon the left-hand side of the engine. The reach rod is operated by a reversing screw in a manner similar to that adopted by most European engineers, which, while it has an advantage over the reversing lever and notched quadrant in the matter of fine adjustments of cut-offs, has the disadvantage of slowness of motion. At the base of the stack, too, there is a collar something like an Elizabethan ruff without the tucks that serves as a cinder catcher in conjunction with the conical flares that surround the top of the exhaust nozzle. The system of equalizing the weight upon the truck wheels is somewhat more elaborate than that to which we are accustomed, and could not be easily applied with a pivoted or bogie truck. It will be noticed, too, that in the equalization of the driving-wheels more weight is put upon the back than upon the forward drivers.

The frame is of the plate type, cut out in the usual European manner for the axle boxes. The valve motion is of the Stephenson type, with straight links; and here, instead of having the link block pivoted on the lower end of the rocker arm, like the prevailing practice in this country, the rocker is set well forward about on a line with the front ends of the guides, and having its upper arm coming close to the glands of the steam-chest stuffing-box. There are two rods running from the link block to the rocker, so that each part is held on both sides, and thus all side strains are avoided. The fire box is of copper, and the grates are of a type that would be novel for

this country. The flat portion near the back sheet and the inclined portion beneath the brick arch are formed of flat bars interlocked as shown on the plan, while the dumping grate at the front end, and upon which the fire can readily be pushed, serves to empty the fire-box.

The connection between the engine and tender is similar to that in use upon the Pennsylvania Railroad. The radial stays of the crown-sheet are flexible in the two front rows, and there is a cross stay for the shell just above the crown sheet. The deflector above the fire-door serves to throw the air admitted above the fire downward, and this, in conjunction with the



EXPRESS PASSENGER LOCOMOTIVE FOR THE ROYAL SWEDISH RAILROAD.

brick arch, effects a very perfect combustion. The following is a list of the principal dimensions of the locomotive :

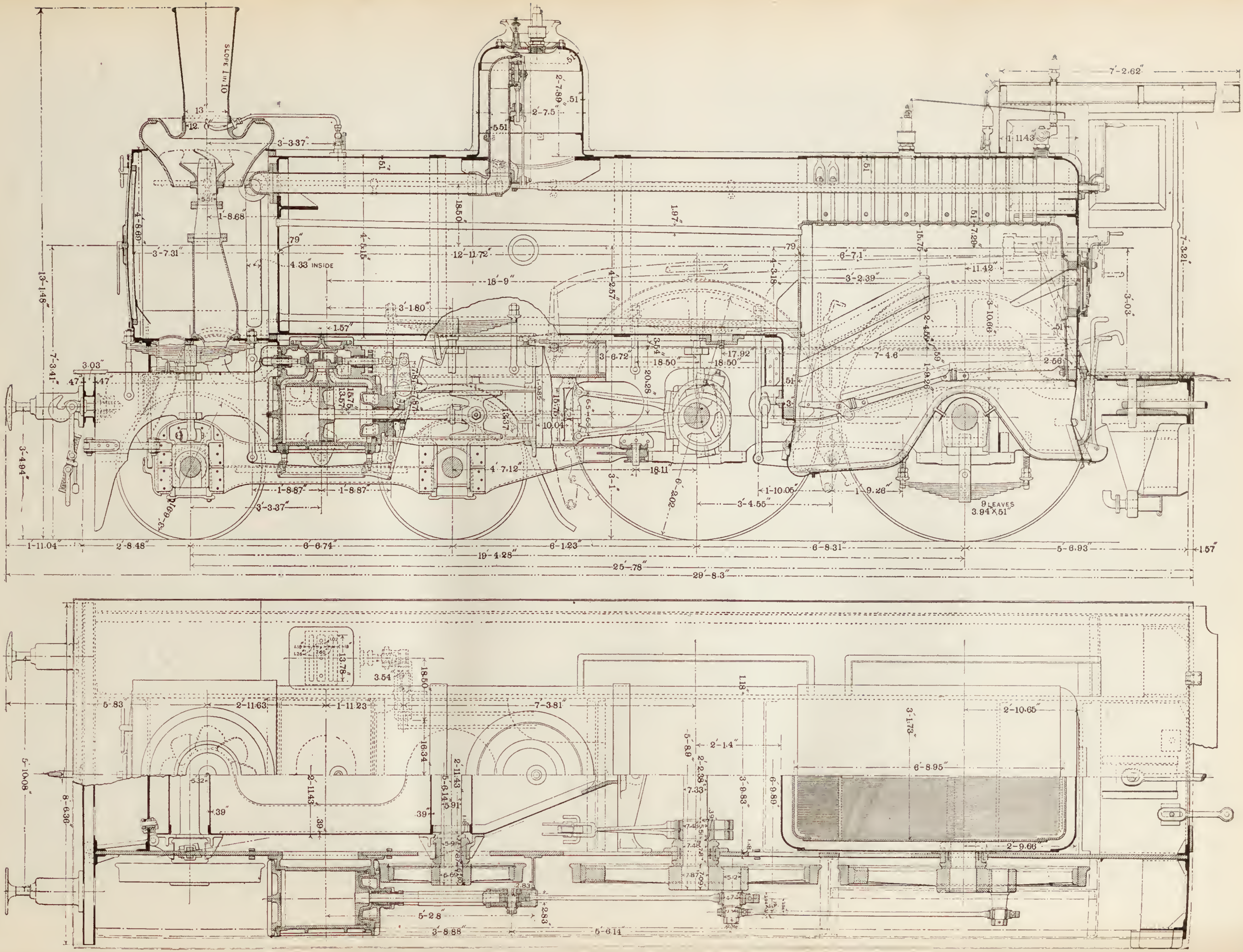
Gauge of road	4 ft. 8.6 in.
Total weight of locomotive in working order	87,615 lbs.
" " on driving-wheels	55,462 lbs.
" wheel base of engine	19 ft. 4.29 in.
Distance between centres of front and back driving-wheels	6 ft. 8.31 in.
Distance from centre of main driving-wheels to centre of cylinders	9 ft. 2.03 in.
Transverse distance from the centre of one cylinder to the centre of the other	6 ft. 2.02 in.
Diameter of cylinder	16.54 in.
Stroke " piston	1 ft. 10.05 in.
Diameter " piston rod	2.08 in.
Width of steam port	1.26 in.
" " exhaust port	2.6 in.
Length of ports	13.78 in.
Outside lap of slide valve	.79 in.
Diameter of driving-wheels	6 ft. 2.02 in.
" " truck-wheels	3 ft. 6.91 in.
" " main driving-axle journal	7.48 in.
Length " " " "	7.87 in.
Diameter " truck-axle journal	5.97 in.
Length " " "	7.87 in.
Diameter " main crank-pin journal	4.74 in.
Length " " " "	3.94 in.
Diameter " side-rod crank-pin journal	3.54 in.
Length " " " "	3.15 in.
" " driving springs centre to centre of hangers.	3 ft. 1 in.
Boiler	Straight top.
Inside diameter of smallest boiler ring	4 ft. 4 12 in.
Thickness of plates in barrel of boiler	.51 in.
Kind of horizontal seams	Sextuple riveted, with inside and outside welts.
" " circumferential seams	Double riveted, with outside welts.
No. of tubes	167
Diameter of tubes, outside	1.97 in.
Length " " over tube plates	13 ft. 1.41 in.
Length of fire-box	6 ft. 8 95 in.
Depth " " (front)	4 ft. 10.46 in.
" " " (back)	3 ft. 10.66 in.
Material inside of fire-box	Copper.
Thickness of side plates of fire-box	.51 in.
" " back " " "	.51 in.
" " crown " " "	.51 in.
" " tube " " "	.79 in.
" " front tube plate	.79 in.
How crown sheet is stayed	Radial stays.
Diameter of dome	2 ft. 7 5 in.
Height " "	2 ft. 7.89 in.
Maximum working pressure	150 lbs. per sq. in.
Grate area	21.31 sq. ft.
Total heating surface	1.209.23 sq. ft.
Kind of blast nozzle	Single.
Smallest inside diameter of stack	12 8 in.
Height from top of rails to top of stack	13 ft. 1.48 in.
Width of grate bars	.51 in.
" " air spaces	.43 in.
Height from top of rails to centre of boiler	7 ft. 3.41 in.
Capacity of coal space	6,160 lbs.
" " water tank	3,700 galls.

ORDNANCE NOTES.

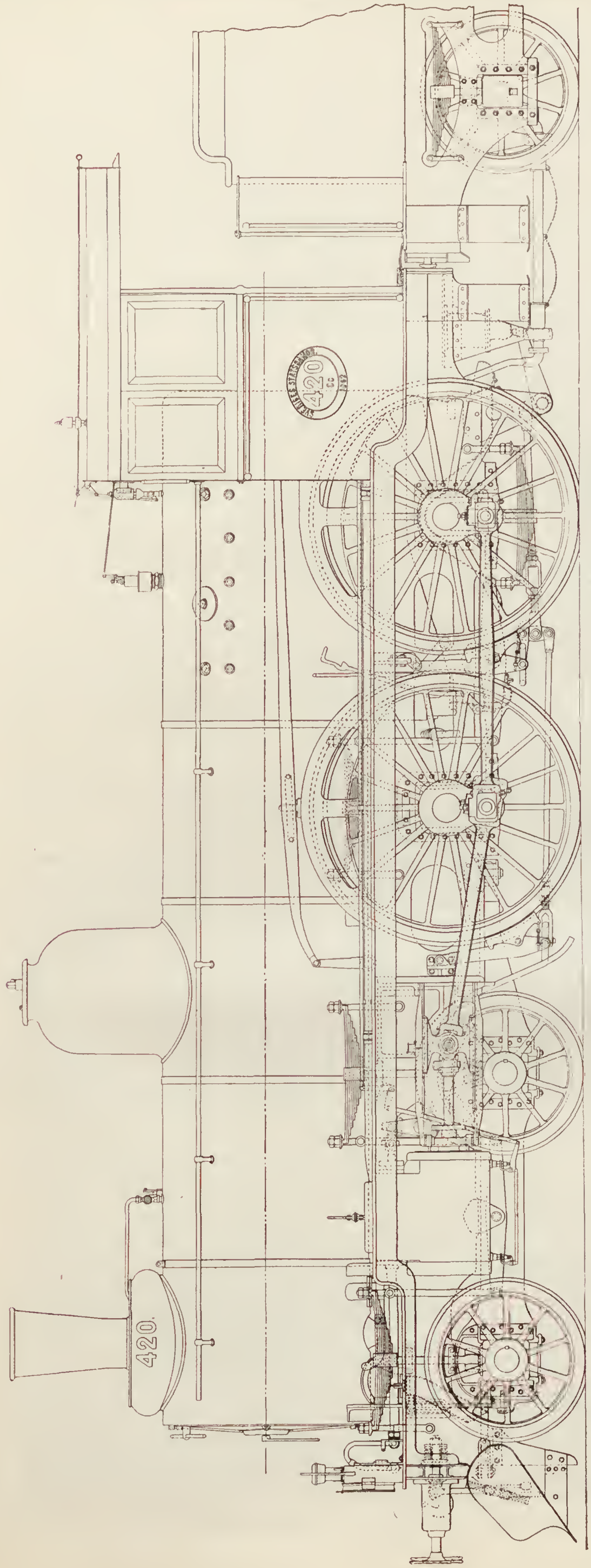
Dangerous Torpedo Practice.—According to the London *Times*, as two torpedo-boats were practising at a target in Portsmouth Harbor, a short time ago, one got across the other's line of fire as it was in the act of letting off a torpedo. The craft was struck with full force amidships, and the torpedo made a large hole in the plating. The vessel was run ashore, but a further mishap awaited her, as she struck on a sunken pile and another hole was knocked in her. She rapidly filled, and sank in shallow water. The boat was raised and lifted on to one of the jetties, where she will be repaired.

The Efficiency of Modern Guns.—At the annual meeting of Sir W. G. Armstrong, Mitchell & Co., the celebrated gun and ship-builders, Lord Armstrong in his annual address, in commenting on the results of the use of their guns in the Chinese-Japanese War, said :

" So far as we have heard, no single gun was rendered unserviceable except by the enemy's fire ; and in one instance where a gun received a direct hit and was dismounted the breech mechanism was still found to be in perfect working order. We have received very flattering recognition of services rendered, together with important orders for further supplies unvaried in pattern. Thus the prediction so commonly expressed—that, however efficacious the refined and elaborate mechanisms of modern artillery might prove in experimental practice, they would be found disappointing under the exciting and rough usage of actual war—has by this experience been completely falsified, and the possibility of a return to simpler and less scientific constructions has been put entirely out of the question. The first elements in the success of the Japanese were undoubtedly their superior scientific training, organization, and discipline, without which the finest weapons cannot count for much. But after due account has been taken of these qualities, the victory of Japan on the sea must be attributed chiefly to the wise foresight of her naval authorities in arming their ships with quick-firing guns. One gun of this type represents a battery of several guns of the old type, and as now constructed by us their range and penetrative power are unsurpassed. The Japanese, in regard to armament and naval material, kept themselves not only abreast, but, if anything, ahead of their times, and recognized the value of the modern weapons as utilizing to the utmost the higher velocities and lower trajectories rendered possible by the use of cordite. This increased power of guns enabled them to operate at a distance too great to permit of effective reply. The carriages of these guns also deserve some special mention. They are highly finished scientific instruments, utterly different from the rough wooden carriages in vogue not so very long ago, which require 12 or 15 men to manœuvre them. Guns of 10 to 12 tons weight that no one in the old days would have thought of placing on board ship at all can now be trained and elevated easily with a single hand, and, in spite of what might be supposed to be the delicacy of the contrivances by which such results are obtained, no single carriage was disabled in the late war except by a direct hit."



EIGHT-WHEELED PASSENGER LOCOMOTIVE FOR THE ROYAL SWEDISH RAILROAD.



EIGHT-WHEELED PASSENGER LOCOMOTIVE FOR THE ROYAL SWEDISH RAILROAD.

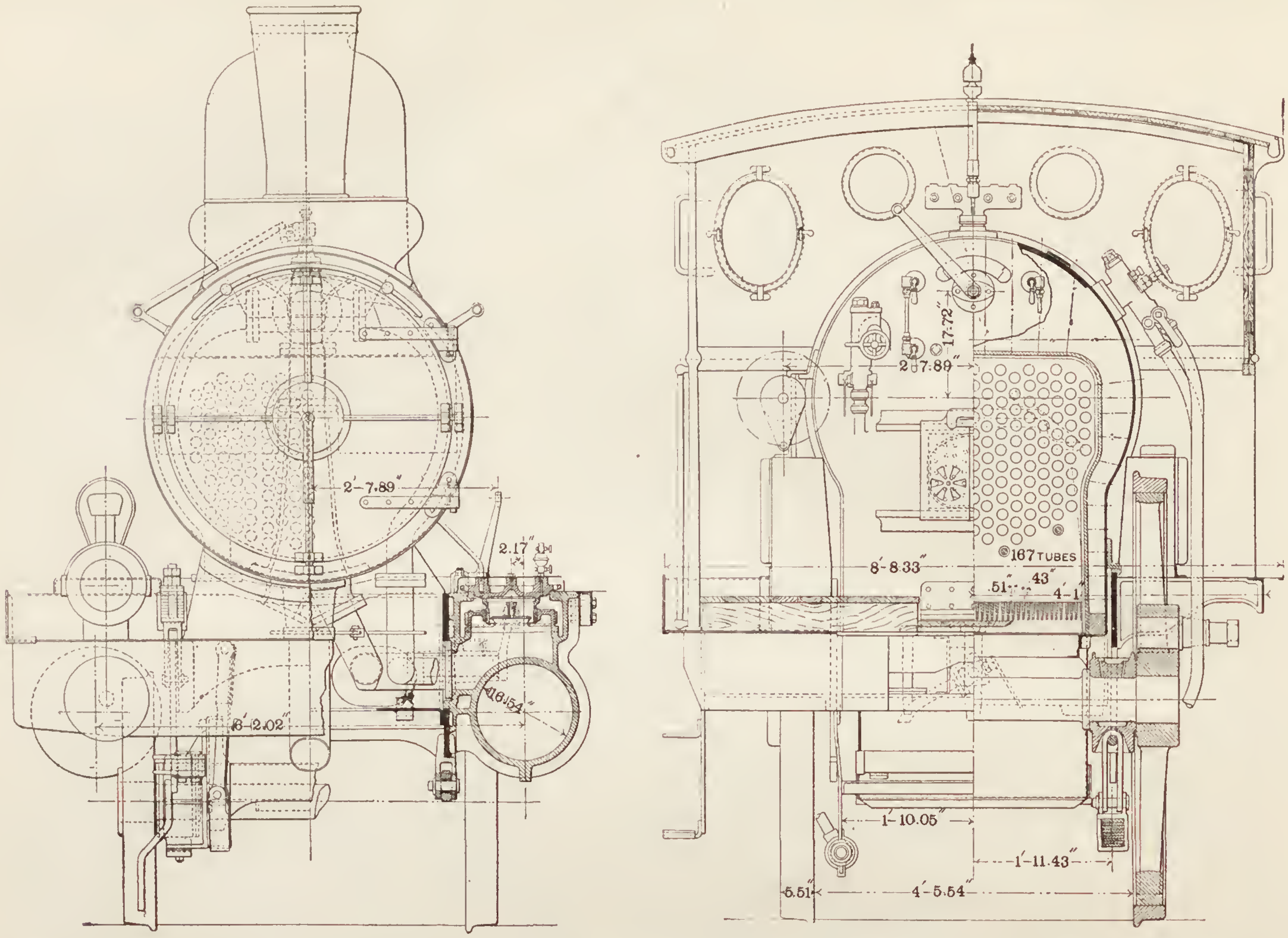
UNITED STATES DREDGING STEAMER "GENERAL C. B. COMSTOCK."

In October, 1894, a contract was entered into by the Bucyrus Steam Shovel & Dredge Company, of South Milwaukee, Wis., to build a hydraulic dredging steamer for the Harbor Improvement Works at Galveston, Tex. The works now being carried out there, under the supervision of Major A. H. Miller, of the United States Engineer Corps, have for their object the creation of a deep-water port, and one of the first and principal necessities was the deepening of the bar which obstructs the entrance to the bay on which the city of Galveston is situated. For a long time this bar has restricted the draft of water of vessels entering the harbor to 10 ft. or 12 ft. The formation is a very fine, hard white sand, and a considerable improvement has been effected by the construction of jetties, so that the ebb and flow of the tide between the jetties helps to create and maintain a deep channel. The action of the tides, however, was insufficient to accomplish the result, and, in order to hasten the work, it became necessary to dredge the bar. The dredging of ocean bars presents a set of conditions entirely different from those met with in ordinary dredging, and a special type of dredging vessel has been developed to meet these conditions. Owing to the exposed situation and the consequent necessity of working in considerable sea-way, it is impracticable to use anchorages of any kind, or to load the material into scows alongside. The type of dredge, therefore, becomes a self-propelling hopper steamer equipped with centrifugal dredging pumps, which pump up the sand from the bar while the vessel is being slowly steamed over it ; the sand being received into the hoppers in the hold of the vessel and discharged at sea through valves in the bottom.

The steamer *General C. B. Comstock* is one of the latest and most complete examples of a vessel of this type, and her trial performance shows that she is capable of very high results. The hull is of wood, 177 ft. long over all ; 35 ft. 6 in. beam ; 16 ft. depth of hold ; and the two hoppers have a collective capacity of 500 cub. yds. when filled to level of main deck. They can, however, be filled considerably higher than this, as they are surrounded by a coaming 33 in. high.

The propelling engines drive the vessel at a speed of 10 miles per hour when light and 8 miles per hour when loaded. Steam is furnished by two marine boilers 10 ft. in diameter by 11 ft. 6. in long, each boiler having two Fox corrugated furnaces. Immediately forward of the hoppers is the pump-room. Here are located two independent centrifugal dredging pumps each driven by compound direct-connected engines of 125 H.P. Each pump has 15 in. suction and discharge, and is specially designed to withstand the abrasion and wear of the sand for the greatest length of time, and to give freedom of flow through the passages. The blades are of steel, and are removable through a manhole in the casing. There is a thrust bearing on the shaft of the pump of the multiple collar type, and an intercepting chamber provides for the exclusion of the sand from pump shaft bearing. The cranks are balanced, and the engines run smoothly and steadily at 200 revolutions, but in ordinary work the speed is about 185 revolutions.

The suction pipes enter through the side of the boat just above the load water-line. There is a heavy flanged socket casting fitted into the side of the vessel, which receives the swivel elbow of the suction pipe. This elbow is a steel casting, and has sufficient length of bearing in the socket to hold it in place and take the entire strain of the suction pipe without any additional support. The stuffing-box for the elbow is inside the boat, and easy of access from the pump-room. The suction-pipe is 50 ft. long, in two sections, and made of wrought-iron welded tubing. There are two flexible connections in the pipe to permit



HALF FRONT ELEVATION. HALF SECTION AT CYLINDERS. HALF REAR ELEVATION. HALF SECTION THROUGH FIREBOX.

EIGHT-WHEELED PASSENGER LOCOMOTIVE FOR THE ROYAL SWEDISH RAILROAD.

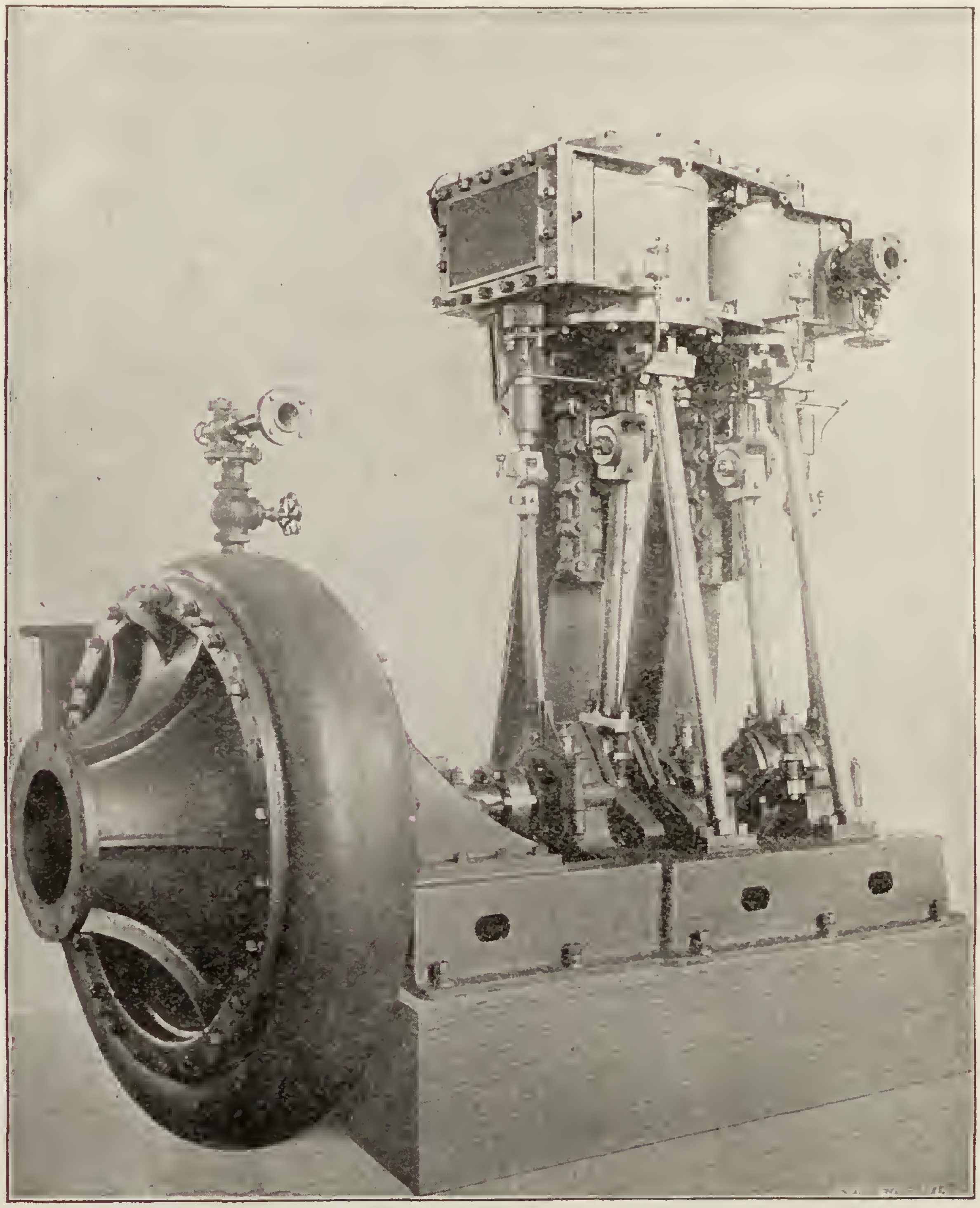
UNITED STATES DREDGING STEAMER "GENERAL C. B. COMSTOCK."

freedom of movement in a seaway under all conditions. The drag at the lower end of the suction pipe is of cast iron, and so arranged that if it should encounter any immovable obstruction it will raise up and pass over it automatically without unduly straining the suction pipe. The suction pipes are suspended on each side from two steam cranes with wire rope hoisting tackle, by means of which they are readily raised or lowered to the required depth. A spring indicator on the crane shows the tension of the ropes and the degree of pressure of the drag upon the bottom. The drag is furnished with removable steel cutting blades.

From the pumps the discharge is carried forward over the hoppers in two large troughs which have openings or slides at suitable intervals, so that the material can be properly distributed in the hoppers. The discharge of the pumps consists of a mixture of sand and water, the percentage of sand varying from 10 to 40, according to circumstances. The water overflows from the hoppers through suitable openings, passing over the deck, while the sand precipitates in the hoppers. During the trial the hoppers were filled with water only in 4½ minutes, with both pumps running. This is equal to a capacity of 11,000 galls. per minute for each pump. The time occupied in opening the valves and discharging the load is 7½ minutes.

The vessel is equipped with Providence steam windlass, Chase steam steering gear, Westinghouse electric light system, Huntington search lights, and a full equipment of everything that goes to make up a complete sea-going vessel. The crews and officers' quarters are ample and commodious and constructed over the hoppers, and are specially designed for a warm climate. Pilot-house and bridge is placed forward. There are two masts, each fitted with derrick booms arranged for handling the suction pipes and all her own machinery. Complete awnings are provided over both forward and after decks.

The propelling engines are by Neafie & Levy Company, of Philadelphia, and the hull was built at the yards of Hugh Ramsay, Perth Amboy, N. J. The vessel steamed to her destination, arriving there August 31, and her trial tests have been satisfactorily completed and the vessel accepted by the Government. The vessel was built from the designs of A. W. Robinson, M. Am. Soc. C. E., who also designed the pumps, pumping engines and dredging equipment, and which were built at the works of his company at South Milwaukee, Wis.



ENGINES OF THE UNITED STATES STEAMER, "GENERAL C. B. COMSTOCK."

A DOUBLE ANGLE-SHEARING MACHINE.

In our issue for May we published an article on the adaptation of the electric motor for certain classes of heavy work, in which an attempt was made to show that there are many cases where heavy work is to be done that it is cheaper and better to take the machine to the work than it is to reverse the process, as we usually find it done. This same principle has been in part applied to the heavy double-angle shearing machine that is made by Hilles & Jones Company, of Wilmington, Del. The machine is not of that portable nature that permits it to be moved about the yard or hoisted to the top of the scrap heap, as we found to be the case with many machines driven by electric motors, but it is set upon a turntable, so that scrap or material can be heaped or piled up in a circle about it and the face of the machine turned opposite that portion of the pile upon which work is to be done, thus avoiding the expense of unnecessary handling, and reducing the time required for the performance of the work to the lowest possible limit.

Our illustrations, which are reproductions of photographs, give a clear idea of the construction. It will be seen that the machine stands upon conical roller bearings having a diameter of 8 ft. at the outer ends. There are 20 of these rollers, and just beneath their lower bearing surface there is a circular rack with which the small hand-operated pinion meshes. This is used for turning the machine, and as this is done so infrequently, the application of power for the purpose is unnecessary. It is at the front, and is clearly seen in the engraving of the front view.

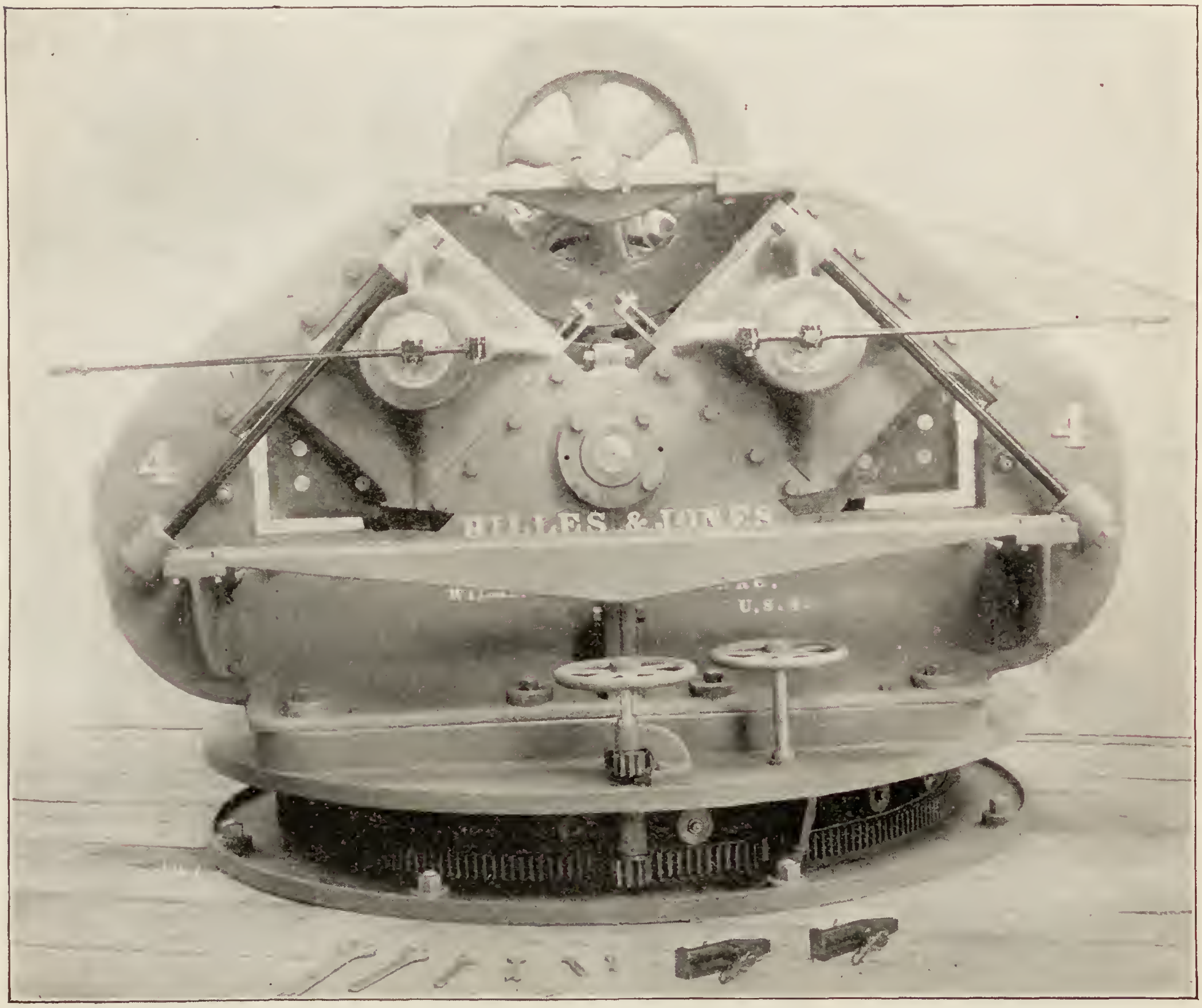
The machine is practically two combined in one, for there are two sliding heads, each working at an angle of 45° with the vertical, and adapted for angle cutting, only one of which, however, appears in the engraving. These cutters are thrown out far enough to one side so that a long bar placed in position will clear all of the working parts at the back. The capacity is equal to the shearing of 8 in. × 8 in. × 1 in. steel angles, which speaks for its strength, while the engraving shows the massiveness of the frame and working parts.

The shears are driven by independent spindles controlled by separate clutches, the engaging lever of one of them being shown over the top of the frame at the right of the rear view, while both are clearly shown in the view from the front. At the back the moving head is counterbalanced by a heavy weight on the driving spindle.

Power is supplied by a self-contained engine having a cylinder diameter of 10 in. and a piston stroke of 12 in., intended to run at a speed of 250 revolutions per minute. Steam is brought to the engine and the exhaust carried away by means of the pip-

ing running in from the centre of the table. This engine is bolted to the back framing, and can thus be easily removed for repairs. With the arrangement of steam pipes employed, the use of any overhead steam pipes is entirely done away with and the machine can be placed in any part of the shop with entire freedom for the crane to travel over it. The revolving table is 10 ft. in diameter, thus forming a large and substantial base plate, upon which the weight of the machine rests; a weight which, with the table itself, amounts to about 50,000 lbs.

The gearing shown consists of a pinion on the engine shaft driving a spur gear on an intermediate shaft that in turn through a hooded pinion drives the two spur gears on the spindles. The teeth of these gears are naturally very heavy, the face being 12 in. and the pitch 3 in.



DOUBLE ANGLE-SHEARING MACHINE, BUILT BY HILLES & JONES COMPANY, WILMINGTON, DEL. FRONT VIEW.

MARINE NOTES.

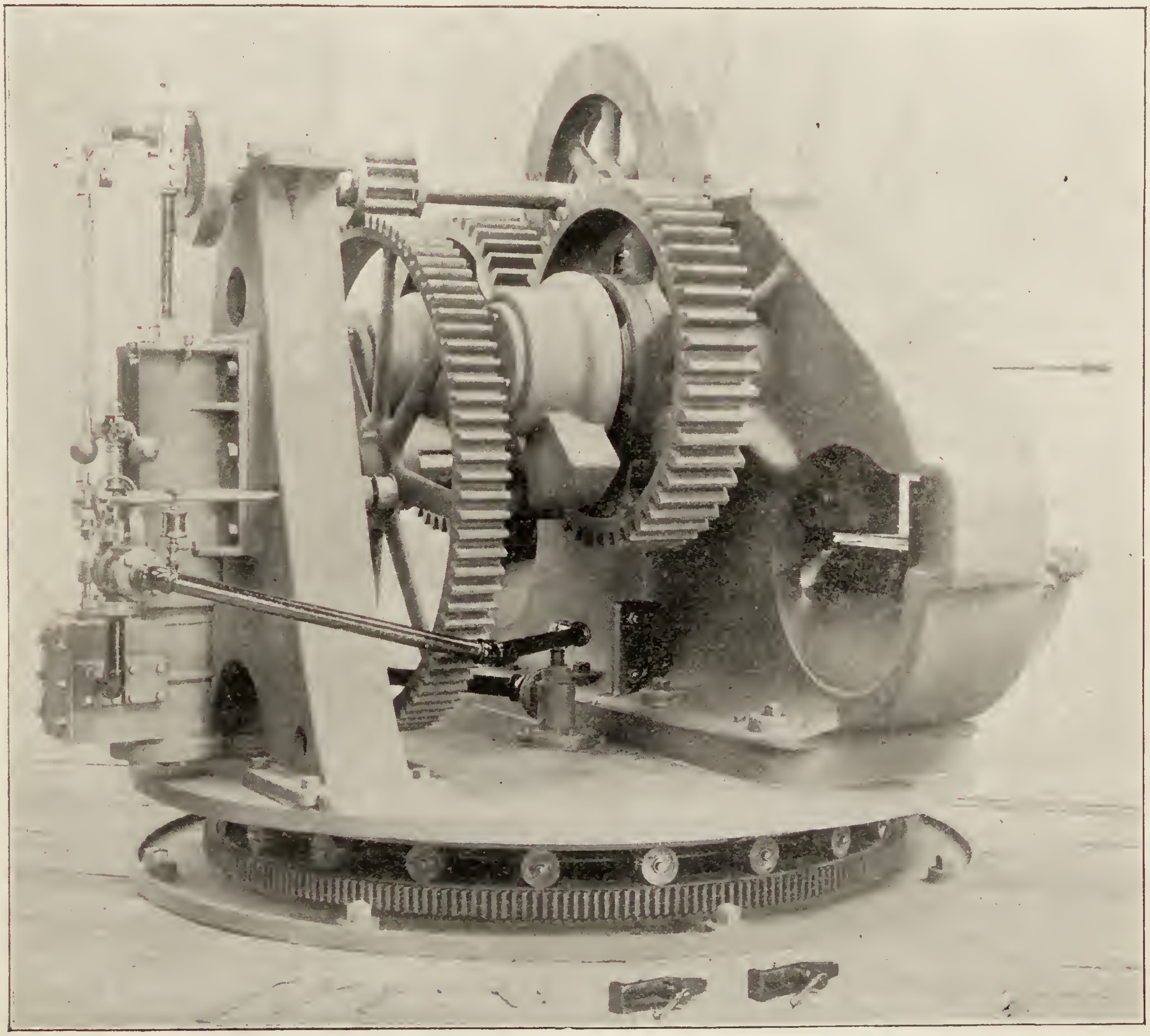
Cadet Engineers from Scientific Schools.—According to a correspondent of the New York *Sun*, "Congress will be asked, probably at the coming session, to pass a law allowing graduates of institutes of technology and similar scientific schools to be appointed as cadet engineers in the Navy, provided they have shown an aptitude for naval engineering, and provided also those institutions establish an engineering course satisfactory to the Chief of the Bureau of Steam Engineering and to the Secretary of the Navy. On being appointed, such graduates would be sent to sea for two years, and would also receive special instruction suited for their proposed calling, and then would be appointed assistant engineers, should they pass a satisfactory examination, or otherwise would be discharged with a year's pay."

The object of this proposed measure is to secure more engineers for the Navy, the academy at Annapolis not yielding enough, as the majority of cadets prefer the line if they can get it.

New Torpedo-boat Destroyer "Sokol."—The London *Times* gives an account of the launching, on August 22, of this boat—the name of which in English means Hawk—from the shipyard and engine works of Messrs. Yarrow & Co. The boat has been built by that firm for the Russian Government. She is 190 ft. long, 18 ft. 6 in. beam, and has a displacement of about 240 tons, is the first destroyer in which nickel steel has been adopted as the material of construction, it having about 30 per cent. greater strength than the ordinary mild steel usually employed. She is fitted by her builders with their special type of twin-screw triple-expansion engines to indicate about 4,000 H.P., and estimated to give her a speed of 29 knots, the steam for driving them being supplied at a pressure of 200 lbs. per square inch by eight Yarrow water-tube boilers, having straight steel tubes, of which a large number have now been adopted in similar vessels for the British Government.

The *Sokol* was launched with engines, boilers, and all auxiliary machinery in place, and within an hour from taking the water had steam up and her engines in motion, followed

by her attaining, when going through a series of preliminary trials, a speed which is unprecedented in the records of any similar vessels in this or any other country. At 2 P.M. on Friday the vessel was on the stocks, at 8 A.M. on Saturday she left Messrs. Yarrow's works and proceeded down the river, and, on reaching the Maplins, increasing speed trials were undergone, giving as results: First speed, 25.8; second, 27.8; third, 29.26; fourth, 30.285 knots, these being in each case the mean speed attained on each set of runs made, the highest speed being realized with 416 revolutions of the engines per minute and the very moderate steam pressure of 170 lbs. per square inch at the boilers, the air pressure never exceeding $1\frac{3}{16}$ in. of water.



DOUBLE ANGLE SHEARING MACHINE, BUILT BY HILLES & JONES COMPANY, WILMINGTON, DEL. REAR VIEW.

PROCEEDINGS OF SOCIETIES.

Master Car-Builders' Association.—The committee on the Location of Air-Brake Cylinders on Freight Cars, having in view easy access in cleaning and repairing, have sent out a circular of inquiry for information and recommendations.

"In view of the large number of cars now equipped with air brakes, which number is being added to daily, the necessity of repairs to these parts is increasing, and is becoming an important factor in the interchange of cars. Therefore the best methods of applying the air-brake apparatus to facilitate the repairs and care of such parts, and avoid delays to cars or freight at terminals and in freight yards, should receive careful consideration. The committee therefore believes that all members fully appreciate the importance of this question, and, with a view of obtaining best results possible, respectfully asks all members of the Association to assist the committee as far as possible by answering this circular at an early date, and giving any and all data which might be beneficial to the committee and assist it in making report."

The questions asked are:

"1. What, in your opinion, is the best location for air-brake cylinders and reservoirs on the following classes of cars, having in view easy access for cleaning and repairing, as well as protecting air-brake apparatus as much as possible in case of derailment: Hopper bottom coal cars, box and stock cars, drop bottom gondolas, straight bottom gondolas?

"2. Do you recommend that cylinder be located low enough so that rods will clear needle beams, or do you recommend cutting passage through needle beam for rods?

"3. Do you consider it an advantage in regulating the braking power to have the rod from the cylinder lever to truck lever stand parallel with the car? Also give your opinion as to the necessity for having the rod between the cylinder and floating lever stand in a line parallel with the car.

"4. What distance would you recommend between needle beams and cylinders to give easy access for repairs and cleaning? What distance between triple valve and needle beam?

"5. What, in your opinion, is the best practice in applying release valves on coal cars?

"6. Has your experience demonstrated whether the water

dropping on apparatus after passing through the coal on coal cars has any damaging effect on the brake apparatus by reason of the chemical properties in the coal?

"7. Please give drawing, sketch, or any other information on the subject which, in your opinion, might aid the committee.

"Please send your answer to the chairman of the committee, James Macbeth, M. C. B., New York Central & Hudson River Railroad Company, East Buffalo, N. Y."

A Military Bicycle Association.—The first annual convention of the United States Military Wheelmen was held at the Broadway Central Hotel recently. It was called for the purpose of inviting all the officers and soldiers and ex-officers and soldiers of the regular or volunteer armies of the United States or of the National Guards of the various States who are wheelmen to meet and express their views in relation to the utility of the bicycle for military manœuvres. This is a new organization, in which it is proposed to unite wheelmen who have a knowledge of military drill into bodies of such size as to test the practicability of moving and manœuvring large bodies of troops with the bicycle.

Addresses were made by prominent military men. The topics discussed were: The proper weight of the military bicycle; proper arms for cyclists; what weight of clothing should be carried? the cyclist as a topographer; should the gun be on the machine or man? should the military machine have a brake? machine guns carried on tricycles; the steam carriage as a practical military machine; foreign governments and the like; should the United States Government establish a bicycle corps?

Major Geddings, of Connecticut, reported that the National Guard in his State had organized a wheeling corps, and have experimented with the bicycle extensively in connection with military tactics with very promising results.

The consensus of opinion in relation to the weight of the bicycle for military use favored 20 lbs. to 25 lbs. The tires for military bicycles, it was conceded, should be pneumatic, and heavier than the ordinary tire. Regarding the proper gun equipment of the military cyclist, different opinions were ventured. Some suggested the use of revolvers, to be carried on the person of the rider, with all other arms strapped to the machine within convenient reach for quick action.

The meeting was in session throughout the day and evening, when papers were read on the relation of the bicycle to the army. It was admitted that for courier service, picket, and scouting duties the bicycle will prove to be a valuable and indispensable adjunct to the army. General Nelson A. Miles spoke at length upon the bicycle and its military advantages, and said that military men were always slow to adopt new improvements. Flint locks survived in the Mexican War years after the percussion cap had been invented, and the army went into the War of Secession with muzzle-loaders, while long before hunters had used breech-loaders. The question is: How far can we use it for military purposes? We have seen enough to convince many men that it will be one of the most useful appliances in war. I have heard it said that you cannot manœuvre large bodies of men on bicycles. I have heard men make that statement, but there are some men who couldn't manœuvre large bodies of men on horse, foot, bicycle, or any other way. Bicycles can be used by men who believe in the bicycle; who have confidence in it, and know that it can be used for war purposes. It can be used in some places where a horse cannot be used. The horse can be used in some places where the bicycle cannot be used. You cannot swim a river on a bicycle, but you can conceal it there for several days, fish it up, and ride away, which you cannot do with a horse. There are many uses and means to which you can apply a bicycle where you cannot use a horse, and where a man cannot perform the same service on foot.

General Albert A. Ordway, District of Columbia Militia, was elected President. Verily the world moves!

PERSONALS.

Mr. Coleman Sellers and his son Horace announce that they have removed their engineering office to Rooms 537–539 Philadelphia Bourse, in Philadelphia.

Mr. H. B. Hodges has been appointed Superintendent of Tests of the Southern and Alabama Great Southern Railway companies, with an office at 1300 Pennsylvania Avenue, Washington, D. C. He will provide specifications for and have charge of the inspection of all supplies, except ties and lumber, purchased for the various departments of the system, and will arrange for such mechanical and chemical tests as may be necessary to insure the fitness of the material for service. He will send his reports of such inspections and tests to the general storekeeper, and no new material purchased under specifications shall be issued unless accepted by the superintendent of tests. He will conduct all investigations of and experiments with new devices and appliances referred to him for this purpose by heads of departments, including such tests as are made in the company's laboratories, as well as in actual service on the road, and will furnish the results of such investigations to officers interested. He will investigate, when requested, the failures of rails, wheels, axles, etc., and the cause of hot boxes. All waters used will be analyzed in the company's laboratory, and no changes in the supply will be made except upon favorable report from the superintendent of tests. He will carry out any scientific investigation, and perform such other duties as may be assigned him by the second vice-president, and will report to that officer.

FORTY MILES DEEP.

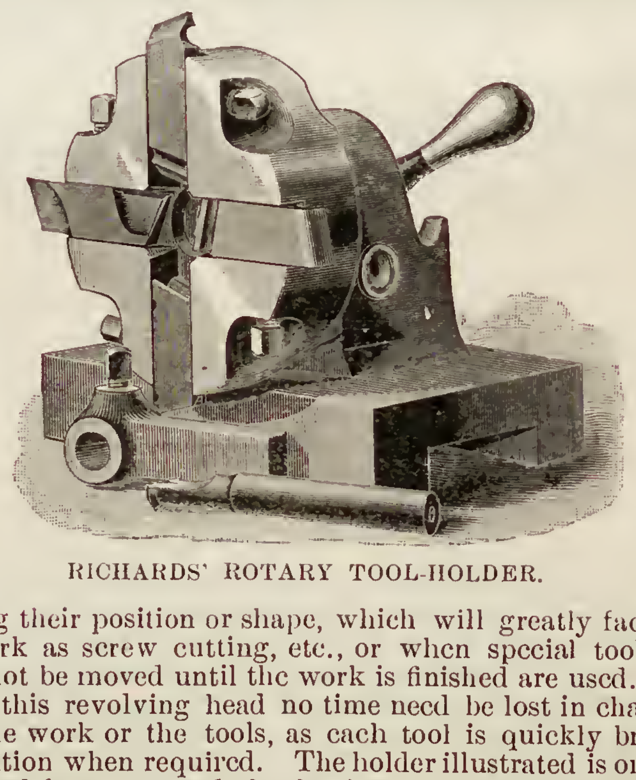
To the Editor of The American Engineer:

"Seeing that the atmosphere is 40 miles deep all around the globe," says Horace Mann, it is a useless piece of economy to breathe it more than once. As it is, we are prodigals of health, of which we have so little, and niggards of air, of which we have so much. Sixty passengers in an ordinary car will breathe all the air contained in the car in one and one-third minutes. A method of replacing all the air in a car, and that without draft, dust, or cinders every minute, and withdrawing the vitiated air at the same time, would seem a blessing to every traveller on railroads. Yet this has been done, and several cars on the Boston & Maine Railroad have been fitted with a system of ventilation which accomplishes just the above conditions. These cars are warmer in winter and cooler in summer than ordinary cars by 11°. The cost of application is nothing additional in building new cars, and can be readily applied to old cars at a small cost. No attention whatever is required in this arrangement. The air comes in and goes out, and the headache, dull feeling, sleepiness which is induced by breathing carbonic acid gas is entirely absent in these cars. Let us have health and comfort when it costs nothing at least.

C. M. Fuller.

RICHARDS' ROTARY TOOL-HOLDER.

This tool-holder, which is made by Mr. I. P. Richards, of Providence, R. I., is designed to take the place of the common tool-post for engine lathes. It consists of a circular head with radial channels cut in its face for holding a number of different tools at once, which may be set in different positions, so as to finish the work without any changing. Each tool is held independently of the others by its own set screw, as shown in the engraving. It can thus be raised or lowered or run in or out as the work to be done may require. Another important feature for some cases is that the tools can be ground without



RICHARDS' ROTARY TOOL-HOLDER.

changing their position or shape, which will greatly facilitate such work as screw cutting, etc., or when special tools that should not be moved until the work is finished are used.

With this revolving head no time need be lost in changing either the work or the tools, as each tool is quickly brought into position when required. The holder illustrated is one that is intended for use on a lathe having a swing of 16 in. The head is 6 in. in diameter, and the channels will receive 1 in. steel for tools.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

The American Railroad Journal, founded in 1832, was consolidated with Van Nostrand's Engineering Magazine, 1887, forming the Railroad and Engineering Journal, the name of which was changed to the American Engineer and Railroad Journal, January, 1893.

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NEW YORK, NOVEMBER 28, 1895.

EDITORIAL NOTES.

CONDUIT systems seem to be attracting considerable attention in different quarters ; and it may be confidently expected that the coming year will see unusual activity in this line. Two are now in operation in the United States, the "Love" system in Washington and the Lenox Avenue Line, constructed upon a closely similar plan, in New York. It is now rumored that a number of cable companies are looking to the substitution at an early day of wires in lieu of their existing cables. So far all these new systems are going in upon an open-slotted conduit plan, with continuous bare conductors. This, with one exception—the Madison or Fourth Avenue Line, in New York—will give the accumulator system another chance.

Philadelphia, however, which has always been in the lead in traction matters, and taught us in New York how to lay and run a cable, has probably taught us an expensive lesson ; that city will have no cable now, and no conduit of any kind, but has surrendered nearly all its lines to the overhead trolley, which is being installed everywhere as fast as possible, while the cables are coming up ; and doubtless this bit of history will erelong be repeated here. We shall continue to hope that in the rush for something new we shall somewhere see at least one closed conduit system tried having a sectional midrail conductor, without bare wires anywhere.

THE article in another column describing a new form of fire-brick fire-box for locomotive boilers is suggestive of the attempts that have been made for a number of years to do away with the expense and inherent evils of the fire-box as it is now constructed. It seems to have been demonstrated that an evaporative efficiency equal to the present fire-box can be obtained with the brick-lined arrangement, but there must be some practical objections in the line of maintenance that are developed in the course of the experiments that are either belittled or concealed. The brick arch has shown itself to be so valuable that it is taken as a matter of course, and yet there are some roads that have been compelled to abandon it on certain divisions owing to the combination of bad water and bad coal rendering it impossible to support the brick. The tubes will fill with mud and scale despite the rapid circulation that passes through them. But though abandoned in some places, the brick arch continues to hold its own. It would seem probable, then, that it only remains to devise some means to hold the brick of a lined furnace securely in position beyond all possibility of a collapse in order to bring this old system that is continually cropping out in new forms into practice to such an extent as to give so thorough a demonstration of its value that it must survive or perish with the results.

THE introduction of the electric locomotive for ordinary railway work will bring many new and interesting problems before the designer of these engines. So novel do these electric engines look, that one recognizes hardly a single familiar feature of the large old-time locomotive. A peculiar point in the design of the Baltimore locomotive arose from the necessity of making some provision whereby the swaying and side thrusts that must necessarily take place on curves should not be allowed to seriously displace the revolving armature in the field of the motor. The armatures of these multipolar motors are on the axles of the drivers, and turn with the latter ; they are not, however, rigidly secured to them, but are fastened by yielding connections which allow the axle of the driver to be considerably out of the true centre line of the armature, but without displacing the latter with reference to the field of the motor. Problems like these are new to locomotive engineering, and will doubtless be productive of an entirely new school of design.

Where boiler and water are both absent from the locomotive, other means must provide for this loss of weight in order to maintain the necessary tractile powers. Hence we find in the Baltimore engine very heavy frame-work for the trucks, and the motor fields are very massive, and the centre of gravity of the whole structure can be brought much lower in the electric engine than in the steam locomotive, where the weight of boiler and water must generally be altogether above the axles of the drivers. In the electric locomotive it will be far easier to use drivers of 8 ft. or 9 ft. in diameter, or even more ; inasmuch as the centre of gravity can easily be brought below the axles, we can obtain the same degree of steadiness with drivers of much larger dimensions than those in common use to-day. The utter lack of tender and all reciprocating machinery are alike conducive to simplicity of design as well as comparatively low cost. On the other hand, motor dynamos will also be used for supplying light to the trains, and the air-brakes will probably be operated by compressed air, the pressure of which will be supplied by air compressors driven by electric motors.

All these features combine to introduce entirely new and highly interesting problems of design in the arrangement and construction of the coming electric locomotive.

ELECTRIC RAILWAYS.

IT is now only seven years since the first trolley line was put into operation, with grave doubts and misgivings as to its future. No single development in the engineering world, however, has seen such rapid growth and well-deserved success. Since the first trolley in Richmond, Va., itself a financial failure at the outset, more than 800 trolley roads have gone into operation throughout the United States on the lines of a system long regarded by eminent engineers as of doubtful value.

The growth of the trolley in this country has been unique, in that it has in a sense created its own field and made its own

market; and while city traction systems seem to be slowly but almost certainly coming over to electricity, as evidenced by the recent change in Philadelphia, this departure has been only secondary to the great demand for new roads in suburban districts, which by their invariable selection of an electrical system have given the trolley a chance to establish its merits on a foundation so secure that city systems, where, for one reason or another, a change must be had, are gradually turning to the trolley for a solution of their difficulties.

We shall aim to keep our readers in touch with this development from both the railroad and the engineering point of view; and while we are not among those who look for electricity to displace steam in general railway traffic, even in a remote future, as some of our more enthusiastic contemporaries would have us believe, we are fully alive to the growing importance and value of these new systems and of their daily increasing interest to both the civil and the mechanical engineer. We shall not endeavor to give a technical review of electrical progress—this is the province of the electrical paper pure and simple; but shall keep close track of such practical advance as will prove of immediate interest to the railway mechanic and engineer.

A consideration of practical applications and different systems of railway and car construction and motors, as well as central station detail and management, will come within our province, and we will thank our readers for information of any new developments that come to their notice.

While it is hardly safe now to predict in this country the early advent of the so-called "underground trolley" systems, their recent adoption on two important lines of New York City appears significant, and may give a stimulus to this type of system that will lead to radical change and interesting developments in city systems, where the overhead wire will always be more or less objectionable. If the Lenox Avenue Line, in New York, with its bare conductors less than 2 ft. apart in an open or slotted conduit, should work satisfactorily or even without interruption through the winter, we may expect to see a degree of confidence restored to systems of this class which repeated failure and defeat have shaken in former trials. It is to be hoped that these failures were the fault of defective construction, and not inherent in the system.

The present advance lies evidently in this direction, for close upon the heels of the Lenox Avenue experiment we are informed that another uptown avenue line—not in the Metropolitan syndicate—is to lay a slotted conduit underground trolley system. Significant among the changes to electric systems is the proposed alteration of the switching systems at the ends of the Brooklyn Bridge. This service has heretofore been performed by steam motors handling 75 trains an hour.

It is stated that an overhead trolley system will be installed, the bridge construction being well suited to an overhead wire system. Will it be, indeed, a rash prediction that this change is only a precursor of a more radical one in the near future—that of the entire bridge cable to a "midrail electric system," to the construction of which the bridge road is well adapted.

In the past year the most eventful feature in electrical engineering has been the equipment of the Baltimore tunnel with electric locomotives designed to haul for a few miles the regular traffic of the Baltimore & Ohio Road. Two electric locomotives, properly so called, as they weigh 96 tons, will perform this service, taking both the fast express and the heaviest freight trains through the tunnel under the city at the customary speeds. Being the first locomotives designed to do the work of the heaviest steam locomotives, their performance will be watched for some time with continued interest. Recent reports of very severe tests are of the most encouraging sort, and the fact seems established beyond the peradventure of a doubt that an electric locomotive for any desired work can now be built.

Probably the next step in heavy railway work will be in the line of a high-tension system, either by direct or alternating currents having a voltage of a thousand or more, sufficient at least to insure economical operation over 10 miles or more either side of a central station. Such a system has already been projected, that proposes the use of two direct currents of 500 volts each on the two sides of a three-wire system, a 500-volt motor of the ordinary type being placed on each side of the middle wire in precisely the same manner as two 110-volt lamps either side of the neutral wire use the 220 volts of a three-wire lighting system.

Other projected plans contemplate the use of high-tension multiphase alternating currents transformed at intervals to low-tension direct current by rotary transformers.

Although the horseless carriage seems to have surrendered at discretion to the gasoline or petroleum engine, the storage battery in this field is not going to surrender without a fight.

Notwithstanding the fact that in the recent competition in France the vehicles driven by storage batteries made a rather poor showing, we are pleased to learn that the coming competition to take place the last of this month between Chicago and Milwaukee will find at least one electrically driven vehicle of American manufacture in the race.

RAILROAD RACING.

It is evident that a finality has not yet been reached in the matter of fast time on railroads. The public want to travel as fast as possible, and this constant demand is almost certain to influence railroad managers sooner or later, and lead them to give those who travel the fastest possible or practicable trains.

The question is now constantly asked: What is the limit of practicable railroad speed? To which there is not likely to be a final answer given for some time to come. Railroad managers in this country and in Europe are casting about for means of accelerating speed, and there will quite certainly be a continued demand for locomotives which will make faster trains possible. It will be assumed that such a demand has been made and that a locomotive superintendent is required to supply a train to run, say, 70 miles per hour in regular service on a fairly good road. Now, how could this be done?

In reply, it may be observed that if a person should engage in horse racing he would not be likely to select his horses from those best adapted to ordinary coach service, nor would he harness them to a heavy stage coach or omnibus. He would choose a horse with good lungs, light legs, and plenty of muscle. A heavy-limbed, big-bellied and cumbrous beast would not be likely to make fast time. Having his horse, he would hitch him to the lightest of vehicles—like the gossamer-wheeled buggies for which we are noted in this country.

Now, in undertaking to make fast time on railroads, have our locomotive superintendents and railroad managers shown the same kind of sagacity that any horse jockey would exercise if he undertook to win a race or to throw dust into the eyes of his rival out on "the road"? Is it not a fact that the locomotives which have been employed in the notable fast runs in this country have generally been of the class adapted to haul heavy passenger trains at ordinary express speed, and the cars which have composed the train behind the locomotive have been some of the heaviest in day service? The jockey would lighten the load of his horse; but have the railroad managers shown the same kind of astuteness? Or, to put our inquiry into a more definite form, could the fast express trains which have been run in this country be materially lightened and yet carry the same number of passengers that they now do and give them all the accommodations that may reasonably be demanded, and at the same time not diminish the safety of cars in case of accident? It is to such an inquiry that the present article will be devoted.

The weight of the cars which composed the train which made the fast run from Chicago on the New York Central Railroad last September were as follows :

1 Combination car	83,470 lbs.
1 Coach	83,700 "
1 "	82,140 "
1 Wagner car	109,000 "
Load "	2,690 "
Total weight of cars	361,000 "

The train had a seating capacity for 218 passengers, so that the weight of cars *per passenger* was 1,656 lbs. The weight of cars on the New York Elevated Railroad is 24,000 lbs., and they seat 48 passengers, or 500 lbs. per passenger. It will be seen, then, that the cars of the fast train weighed more than three times as much, in proportion to their carrying capacity, as those of the Elevated Railroad. It may be said, and it is believed to be true, that the latter could be run on any good road at the same speed as the fast train made without danger excepting in case of derailment or collision. It is not certain that the journals could be kept cool during long continuous runs, but that is not of immediate importance in our present inquiry. On English railroads six-wheeled cars, weighing very little if any more than those on the elevated road, and seating as many passengers, are constantly run at the highest speeds known in that country. It therefore may be assumed that cars of that weight may be run with safety so long as there are no mishaps, such as derailments or collisions. Now, it is not our intention of inferring hastily that the New York Elevated Railroad cars should be substituted for those which are run, for example, on the Empire Express. All that is suggested is a little reflection on the striking fact that there are cars which it would be safe to *run* (we are not talking about stopping them too suddenly now) at the highest speeds, which weigh less than a third as much as those in use. Now, why could not or should not the elevated railroad cars be used on fast express trains? Obviously for two reasons : first, they would not give the conveniences and comforts which are demanded by travellers now. The seating room, heating and lighting appliances are inadequate. In the climate of New York State double windows are needed in winter, to exclude the cold ; for long runs, water-closets are essential and lavatories desirable. The absence of all these on the light cars would unfit them for fast express service. What is needed in such service is more room for passengers, which will require that the car bodies should be wider than those of the elevated cars. Upholstered seats with reversible backs are demanded for through trains. Steam heat is required by law, and gaslight, parcel racks, and ventilation the public will always demand, although they are not always provided. The essentials, conveniences and comforts of transportation with which each passenger is supplied in the elevated cars weigh 500 lbs. On the fast express, the weight of which is given, these weigh 1,656 lbs., or a difference of 1,156 lbs. The question then comes up whether the additional room which is needed, more comfortable seats, better heating and lighting appliances, water-closets, lavatories, double windows, better ventilation—in short, all that could reasonably be demanded—could not be furnished so as to weigh materially less than 1,156 lbs. per passenger. It is believed that a skilful designer of cars, by the exercise of good judgment and perhaps some ingenuity, could evolve a car which would give travellers all that they could reasonably demand with a very material reduction of weight. The following are the reasons for thinking so. The half of 1,656 lbs.—the weight per passenger of the express cars—is 828 lbs., which is 328 more than the *whole* weight per passenger of the elevated vehicle. Could not the additional conveniences which have been enumerated be supplied and not exceed in weight 328 lbs. for each person? For example, could not a 54-seat passenger car be made with all the required conveniences and comforts and not weigh over 44,712 lbs., or 828 lbs. per passenger? The weights of cars thirty or forty years ago indicate plainly that this is quite within the range of possibility. It is true that the cars of those days did not have the comforts and conveniences which cars are now expected to have, but in those days neither travellers nor car-builders knew how to be comfortable. Such a thing as an easy seat was unknown, and for ventilation we had to depend upon a few round holes in the roof, and for heat upon the mutations of a wood stove and the vagaries of a brakeman. Steel and wrought iron are now available for construction, whereas they were not "when we were boys." A degree of lightness without diminution of strength is, therefore, possible now which was not then. Of course such a car as is here contemplated would require to be designed by a master of the art. He would need to have a thorough knowledge of car construction, and also be accustomed to being comfortable and to a certain amount of luxury. There are many people who don't know how to be comfortable, or when they are so. The most important qualification for such work, though, is that mechanical instinct which is born in some persons and becomes marvellously developed by practice, experience and observation. It is a mixture of mechanical aptitude, inventive ability, good sound sense and judgment and experience in construction.

Let it be supposed that four such cars were designed and built. They would weigh 44,712 lbs. each, and their total weight would be 178,848 lbs., or less than half as much as the train which made the fast run in September, and they would seat 216 passengers. The problem of hauling a train of that weight, at 60 or 70 miles an hour, is a much easier one than to do it with more than double the load at the same speed. The weight of locomotive could also be reduced in the same proportion. Let us see how the problem would stand then :

The locomotive and tender employed on the fast run referred to weighed 204,000 lbs., making the total weight of train 565,000 lbs., or 2,591 lbs. per passenger. With our light cars and an engine of half the weight we will have 178,848 + 102,000 = 280,848, or 1,300 lbs. per passenger. Obviously it will be very much easier to make fast time with a given number of passengers if we must haul only 1,300 lbs. of dead weight for each of them than it would be if we must haul 2,591 lbs.

But the important question of safety must be considered, not alone safety while running, but, as has been said, in cases of collision and derailment. There can be no doubt of the fact that accidents now do much less injury to the occupants of cars than they did before they were made as heavy and as strong as they are now. It is conceded at once that if any diminution in weight of cars would be followed by greater risk and fatality and more injury to their occupants in case of accidents, that the reduction contemplated would have to be abandoned. Cars must be made as strong as possible to resist collisions, and the better able they are to roll down an embankment without being crushed or dismembered, the better chance the people in them have of escaping injury. It should be pointed out, perhaps, that *weight* and *strength* to resist accidents are not synonymous terms. In fact, weight is often the direct cause of injury in accidents. In case of a collision, the chances of the occupants of a New York Central coach to escape injury if the cars behind them were of the New York Elevated pattern would be better than they would be if the rear part of the train was made up of either Wagner or Pullman sleepers. It is, of course, true that if the light cars were in front their occupants would then be exposed to more danger than they would be if they were in heavy cars. All weight which does not add strength is an element of danger and not of safety in case of accident. As a matter of fact, though, it seems doubtful whether

cars generally are specially designed to resist collisions, if we except the construction of their platforms and buffing appliances; and who ever heard of any feature of car construction being adopted because it would make a car stronger to resist rolling over? If we intend to build cars with reference to collisions and rolling down embankments, let us frankly acknowledge it, and employ the very best engineering skill and knowledge to so design their frames as to have the maximum capacity to resist both kinds of accidents, and not pile up destructive weight, and excuse it on the plea that it is intended to resist such disasters. It is doubtful whether the kind of skill referred to—such as has for a long time been employed in the design of roofs and bridges—has ever been exercised in any similar way in an effort to get the maximum amount of resistance to collision and rolling in a car body. It does not seem to be chimerical to believe that if a very high order of designing skill was exercised on the problem, that as much strength in car bodies could be retained as they have now with a very material reduction in weight, and that at the same time every reasonable comfort and convenience in the cars could be provided. If such a reduction in weight was effected, it would make the problem of increased speed a much easier one than it now is.

It was intended to have something to say in this article about locomotives, but cars have occupied so much space that the discussion of the engines must be reserved for a future number.

NEW PUBLICATIONS.

The Practical Application of the Slide Valve and Link Motion to Stationary, Portable, Locomotive and Marine Engines, with New and Simple Methods for Proportioning the Parts. By William S. Auchincloss, C.E. XIII Edition Revised. New York: D. Van Nostrand Company. 138 pp., $5\frac{3}{4} \times 9$ in.

The publishers have issued the thirteenth edition of this well-known book, which they say "has been thoroughly revised by the author, and appears with many additions and improvements." The original edition first appeared more years ago than we like to recall, but our well-worn copy is dated 1869. The book, notwithstanding the fact that it has been before the public so long, still remains perhaps in many ways the best one on the subject.

The engravings—some of them—have been made over and improved, and the dust of a quarter of a century has been brushed from its pages, and the book comes to us like an old friend who has turned up again looking fresh and ruddy.

Modern Examinations of Steam Engineers; or, Practical Theory Explained and Illustrated. By W. H. Wakeman, Instructor in Steam Engineering at the Boardman Manual Training School, New Haven, Conn., etc. Bridgeport, Conn.: American Industrial Publishing Company. 272 pp., $5\frac{1}{4} \times 7\frac{3}{4}$ in. $2.00.

In the sub-title of Mr. Wakeman's book it is said that it "comprises full and complete answers to 300 questions for the use of engineers and firemen when preparing to make application for examination for United States Government and State license, and for the information of engine builders, boilermakers, machinists, etc." The questions are printed in the back part of the book, and after each one the page is given on which the answer may be found.

If this book had to be described in one word, it might be said that it was "rambling." Webster's definition of "ramble" is "to talk or write in a discursive, aimless way," and discursive he defines as "passing from one thing to another," which is what the author of the book under review often does. Thus the title to Chapter III is "Directions to Those who Desire a First-Class License." It occupies nearly four pages, and begins with an explanation why only a small proportion of the licenses issued are first-class, the obvious reason being that "it is easier to get one of the lower grade." There is then an explanation of "lap," and what it is for. This is followed by a description of the ways in which different men go about learning things, with an illustration of how some men, in taking charge of an engine, will note the position and length of its eccentrics, length of its rod, etc. Lap is then taken up again, which is followed by an explanation of lead. In the last paragraph there is a description of how the connection between the crank-shaft and the valves is made. This is followed by observations on setting valves, and the chapter closes with directions for reversing an engine. There are no engravings to illustrate what the writer is explaining, which is a serious defect. A clearly drawn sectional view of a valve would have given an ignorant reader a better idea of what lap and lead are, and would have impressed it on his mind more indelibly than many pages of writing possibly can. There are, in fact, no engravings in the book excepting a few indicator and some other diagrams, which is a very great deficiency.

There are altogether 53 chapters. The first 13 treat of the engine. Then the boiler and its attachments are discussed in seven more. The operation of an engine, including the use of the indicator, consumption of water, expansion and pressure of steam condensers, steam heating, shafting and belting, boiler explosions, strength of boilers and their parts, and strength of tubes, are all discussed.

The book is written in an easy, conversational style which can readily be understood, and there is seldom any difficulty in knowing what the author means. Whether his explanations will be easily understood by those who are ignorant of the subjects about which he has written is doubtful. That they will find it a very useful book there is no doubt, as it abounds with suggestions and hints which ought, at any rate, to put its readers on the track of the information they will need to pass an examination. A candidate for a license, however, would be unwise to depend upon the fragmentary instruction contained in this book to enable him to pass an examination, as the explanations are often inadequate. Thus, on page 191, in discussing boiler explosions, it is said that "those who advocate the idea that all of the water will always flash into steam when the pressure is suddenly relieved are not wholly right, for it cannot be converted into steam unless there is heat enough stored in it to cause it to evaporate, and the necessary heat is not always present." But why don't it? Steam of 100 lbs. pressure has a temperature of 338°. If water is heated to that temperature, why will it not be converted into steam if the pressure is relieved? The candidate for a license, it is to be feared, would be left in a fog if he were questioned about this and had no other information than that which is given him in this book.

If, as may be inferred, the book was intended for uneducated readers, or those with limited amount of book knowledge, putting the rules for making calculations into algebraic formulæ is a mistake. Thus, on page 181, the following formula is given for calculating the size of crank shafts:

$$\sqrt[3]{\frac{D^2 p + d^2 15}{2468}} \times S =$$

Now, imagine a well-meaning, hard-working, faithful fireman, who is quite shaky in the three R's—particularly "rithmetic"—about to apply for an engineer's license, and encountering such a formula. His condition would be pitiful, especially as it is possible to state the rule for making such a calculation verbally and in a form which might be easily comprehensible to him. There is an ailment to which some authors of technical books seem to be subject, which may be called mathematical flatulence, which their patient readers are compelled to endure, but which is inexcusable in books intended for those with only the elements of an education.

The book before us is full of useful hints and suggestions, and doubtless those for whom it was intended will find it of considerable value and will be helped in preparing for their examinations; but it belongs to that class which make a reviewer wonder why the author, having made it as good as he has, did not make it a great deal better.

Rope Driving: A Treatise on the Transmission of Power by Means of Fibrous Ropes. By John J. Flather, Professor of Mechanical Engineering, Purdue University. New York: John Wiley & Sons; London: Chapman & Hall. 221 pp., $5 \times 7\frac{1}{4}$ in. $2 00.

The aim of the author, he says in his preface, in the preparation of this book was "to supply the existing need of a comprehensive manual of practical information concerning rope-driving and the principles upon which the practice rests." The subjects of his chapters are an historical introduction, giving an account of the early use of ropes for driving; multiple rope transmission; continuous rope or wound system; long-distance transmission; fibrous ropes; manufacture of ropes; wear of ropes; H.P. transmitted by ropes; deflection of ropes; losses in rope driving; and construction of rope pulleys.

In his treatment of the subject the author has very largely confined himself to descriptions of existing plants or "drives," as he calls them. These are illustrated by numerous engrav-

ings, but of rather a poor quality. Some of them are process reproductions, which are very bad. Still they generally serve their purpose of making the writer's meaning clear, which is their most important function.

The theoretical portion contained in Chapters VIII to XI is rather formidable looking, and some of the formulæ deduced will scare almost any one excepting a college professor. Taken altogether, though, it is probably the best book on the subject in existence. A somewhat curious fact may be noted in this, as in some other technical books, which is, that the engravings improve as the book advances—those in the back part, in this instance, being very creditable specimens of wax process work.

BOOKS RECEIVED.

Transactions of the Technical Society of the Pacific Coast, January–July, 1895. 94 pp.

A Treatise on Hydraulics. By Henry T. Bovey. 337 pp. New York: John Wiley & Sons.

The Stone Industry in 1894. By William C. Day. 83 pp. Washington: Government Printing Office.

Elements of Descriptive Geometry. By Charles William MacCord. 248 pp. New York: John Wiley & Sons. 248 pp.

Pray's Steam Tables and Engine Constants. By Thomas Pray, Jr. 85 pp. New York: D. Van Nostrand Company.

The Production of Tin in Various Parts of the World. By Charles M. Rolker. 88 pp. Washington: Government Printing Office.

Engineering Contracts and Specifications. By J. B. Johnson, C.E. 417 pp. New York: Engineering News Publishing Company.

Alternating Electric Currents. By Edwin J. Houston and A. E. Kennelly. 225 pp. New York: The W. J. Johnston Company.

The Practical Application of Dynamo Electric Machinery. By Carl K. MacFadden and William D. Ray. 167 pp. Chicago: Laird & Lee.

The Practical Engineer's Pocket-Book and Diary, 1896. Edited by William H. Fowler. 371 pp. Technical Publishing Company, Limited, Manchester, England.

Report of the Queensland Railway Commissioner, for the Year ended on June 30, 1895. 58 pp. and map. Brisbane: By Authority, Edmund Gregory, Government Printer.

Measuring Water. An Address to the Students of Rensselaer Polytechnic Institute, Troy, N. Y. By Clemens Herschell. 28 pp. Reprinted by Builders' Iron Foundry, Providence, R. I.

Engineering Translations. Comprising the Names of 1,600 Technical Parts of Boiler Engines, etc., in English and Spanish. By J. A. Standring. 69 pp. London and New York: Hirschfeld Brothers.

Eighth Special Report of the Commissioners of Labor. *The Housing of the Working People.* Prepared under the Direction of Carroll D. Wright, Commissioner of Labor. By E. R. L. Gould. 461 pp. Washington: Government Printing Office.

TRADE CATALOGUES.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. The advantages of conforming to these sizes have been recognized, not only by railroad men, but outside of railroad circles, and many engineers make a practice of immediately consigning to the waste-basket all catalogues that do not come within a very narrow margin of these standard sizes. They are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

STANDARDS.

For postal-card circulars	3¾ in. × 6⅞ in.
Pamphlets and trade catalogues	3½ in. × 6 in. 6 in. × 9 in. 9 in. × 12 in.
Specifications and letter-paper	8¼ in. × 10¾ in.

Crosby Steam Gauge & Valve Company. This company sends two leaflets, one describing the indicator they make, and the other giving engravings and descriptions of Sargent's electrical attachment, which, it is said, is "an electrical device applicable to an indicator, by means of which any number of instruments can be operated and diagrams taken at the same instant of time."

The Painting of Metallic Surfaces. Harrison Brothers & Co., Philadelphia. 8 pp., 6 × 8 in. [Not standard size.]

This firm, being largely engaged in manufacturing paint, have given here reasons for preferring red lead to any other pigment for painting and protecting metallic surfaces. They also make what they call "Anti-Rust," and recommend the use of red lead as a priming coat, and a second coat of "Anti-Rust."

Barrus' Universal Steam Calorimeter, 1895 Pattern. Gowing & Co., Boston. 8 and 12 pp., 3½ × 6 in. [Standard size.]

The makers of this useful instrument have issued these two little vest-pocket volumes, which give an engraving of the calorimeter with a description, directions for attaching it, and for finding the percentage of moisture and for its general use

Heine Safety Boiler Company, St. Louis. 12 pp., 3½ × 6 in. [Standard size.]

The makers of this boiler here describe the reasons for the claimed superiority of their boiler, the character of their guarantee, and a copy of a letter accompanying a remittance of $1,500 premium to be paid in case certain boilers furnished exceeded their guarantee of evaporating 8 lbs. of water per pound of coal.

The "St. Louis Corliss" Engine. Built exclusively by the St. Louis Iron & Machine Works, St. Louis, Mo. 10 pp., 3⅝ × 6¼ in. [Not standard size.]

The St. Louis Company have issued a vest-pocket description of their works and engines. It contains exterior and interior views of their works, engravings of several styles of engines, and tables of sizes, etc., and ends with a list of prominent purchasers.

Corbitt & Burnham, of Chicago, have issued in type-written form an "argument" on "The New Time Table *vs.* The Old Time Table," and give with it a large engraving of a clock dial, one half of which is black and the other half white, representing respectively the hours of day and night. They also give specimens of the proposed time tables in which the day hours are printed in black letters on a white ground, and the night in white letters on a black ground, the purpose being to make them immediately distinguishable one from the other.

The Life of an Iron Roof; or, how Long will it Last? The Cincinnati Corrugating Company, Piqua, O. 12 pp., 4⅝ × 8 in. [Not standard size.]

That doctors disagree most of us who have had occasion to make use of their services have found out. It seems also to be true of painters. One catalogue, which has just been received, recommends red lead for metal surfaces, while the company whose publication is now before us say that experience teaches them that iron oxide or dry metallic paint reground in pure linseed-oil is the best.

In their pamphlet the corrugating company describe the different kinds of roofs which they make, and give the reasons why they think they are good. The last pages of their book contain testimonials of the superiority of their roofing.

Robinson Radial Truck. Souvenir American Street Railway Association. Robinson Electric Truck & Supply Company, Boston. 20 pp., 6¾ × 9½ in. [Not standard size.]

Apparently the pamphlet before us was intended for distribution at the Street Railway Association's meeting, at Montreal. The Robinson radial truck has three axles, of which the two end ones can turn on a centre pin which is not exactly in the centre of the axle. The middle axle can move laterally but not centrally, and being attached to the frames which carry the end axles, such movement has the effect of turning the two end axles about their centres and bringing them into a position radial to the curve occupied by the car. The principle and construction are shown by outline drawings, and a number of views of cars having this truck are also given.

Punching and Shearing Machinery. Manufactured by the Long & Allstatter Company, Hamilton, O. Catalogue No. 18. 88 pp., 6 × 9 in. [Standard size.]

Although 80 different machines are described and illustrated in this publication, it is said in the preface that "it is not in-

tended to be complete or even descriptive in a general way, but is intended merely to furnish illustrations which will enable those interested to get an idea of the different kinds of machines we build and their construction." Even a person who tries to keep abreast of the progress and development of tools and machinery cannot help but be surprised at the extent of the adaptation and the variety of machines of this kind which are made.

The engravings in this book are the very best kind of woodcuts, most of them made by Ten Eyck, of New York, who is a veteran and a master in this kind of art. It has been remarked in these pages before that there is no method of representing machinery which equals wood-engraving when it is of the very best kind. Even photography will not equal it, because photography represents an object as it appears, or the effect of the light and shade, whereas a good wood-engraver will show a machine as we would like to see it—that is, he will bring out any parts which are obscure, and emphasize those which are relatively of the most importance. Besides Ten Eyck's work, there is some by the McFee Company, of Hamilton, O., and others by the Clegg-Goeser Company, of Cincinnati, which are also so good that it would be invidious to make comparisons. There is one piece of work on page 71 of which the name of the engraver is not given, but which is remarkable. It represents a heavy, double-geared, multiple punching machine with spacing table, designed for perforating plates by punching one complete row of holes after another, and works automatically. The machine itself is admirably engraved; but in the foreground a perforated plate is represented punched full of small square holes and standing on edge, so that it is possible to see through the holes. There are 39 holes in the vertical rows and 43 in the horizontal ones, so that there are altogether 1677 holes represented, each one so accurately cut that they will bear examination under a magnifying-glass. Nor is this all; the legs of the machine, the shadows and shading on the floor showed through these holes, the effect of which is accurately and faithfully reproduced whenever there was any of it to show. One is appalled at the labor involved in doing this, and filled with admiration for the skill displayed in producing this result.

The catalogue is in every way an admirable one. The engraving, printing and typography are all of the best and in excellent taste, and a good index adds to its merits.

THE TRAVELLING CABLEWAY AND SOME OTHER DEVICES EMPLOYED BY CONTRACTORS ON THE CHICAGO MAIN DRAINAGE CANAL. Compiled and Published by the Lidgerwood Manufacturing Company, New York, Chicago and Boston. 72 pp., $5\frac{3}{4} \times 9\frac{1}{4}$ in. [Not standard size.]

It is difficult to know whether to class this publication with "Trade Catalogues" or "New Publications," and it is another illustration of the fact that the best technical literature on some subjects is to be found among trade catalogues. The specimen before us contains first a very good general description and map of the Chicago Main Drainage Canal, with sectional views showing a cross-section of this, the Manchester, North Sea, Baltic and North Sea, Amsterdam canals, from which the reader can quickly get a general idea of the magnitude and character of this great work; and in the following pages the methods and means employed for excavating and conveying the materials from the canal are very lucidly described. The Lidgerwood cableways, conveying devices, and hoisting engines were extensively used, and it is these chiefly which are the subjects of the illustrations and descriptions. Excepting the map and a few line engravings, the illustrations are half-tone engravings made from photographs taken along the line of the canal. This in the rock cuts is a ditch 162 ft. wide, and which will have a mean depth of water of $24\frac{3}{10}$ ft., and in the earth cuts it will be over 300 ft. wide. It is estimated that nearly 40,000,000 cub. yds. of material must be excavated to complete this work, the cost of which will be $27,303,216. It was, therefore, of the utmost importance that means should by adopted for doing the work in the most economical way. The methods chiefly employed were the cableways made by the Lidgerwood Company, and inclined railroads. The former consist of a steel wire cable $2\frac{1}{4}$ in. in diameter, which is stretched transversely to the canal over the tops of two wooden towers; one of them, which is placed near to the edge of the canal, is 73 ft. high, and the other one some distance from it. The span of the cable is usually about 700 ft., so that the highest or head tower is about 500 ft. from the canal. The "spoil bank," on which is the material taken from the canal, is between this tower and the canal. A suitable carriage runs on the main cable, which carries a "skip," which is a square box or bucket 7 ft. square and 2 ft. deep, into which the material is loaded. It is suspended from the travelling carriage by suitable cables and pulleys for hoisting vertically and traversing horizontally, and also for dumping it over the bank. The power is supplied by a Lidgerwood hoisting engine, of which this company have built over 11,000. It would take too much space to describe here all the interesting features of the appliances which have been used in this great work. The book contains 40 views taken along the line of the canal. The descriptions of the appliances are models of conciseness and condensation, and are so interesting withal that the reader who is in any way concerned in engineering work of the character described is not likely to lay it down without reading the whole of it. This brochure gives an excellent idea of the magnitude of this work and of the methods adopted for doing it. While this description of it is issued for gratuitous distribution, the publishers have been extremely modest, and have not inserted any advertisement of their business other than saying that they are the manufacturers of much of the machinery described.

HEADQUARTERS FOR ENGINEERS.

To the Editor of the AMERICAN ENGINEER AND RAILROAD JOURNAL:

SIR: I was much gratified with your editorial in the November 1 issue regarding a great engineering library under the auspices jointly of the national engineering societies. This scheme, with its logical amplification of a joint house for offices, headquarter apartments, assembly halls, etc., is one that I have for several years promulgated among my friends and among the membership of the four great societies. Unfortunately, however, the world seems to be still too young in its civilization for a hearty co-operation of this kind. It cannot even see what you have so ably pointed out—the supreme folly of trying to start a number of little rival libraries—all alike, and inevitably, miserable weaklings.

Upon the occasion of the summer convention of one of the societies in this present year, the subject was discussed at considerable length before some 200 or 300 members, of whom two or three (myself among the number) said all that was possible in favor of such a project, urging the society to have it considered by special committees before going on to purchase real estate for a new house of its own.

Those of us, however, who ventured to constitute ourselves such an exceedingly small minority, found that we were like the traditional juryman who "never saw eleven such contrary men in his life" as were his colleagues, and we regretfully saw the scheme absolutely killed. The chief burden of argument on the part of the "contrary" majority was the "impossibility" of carrying out such a scheme, the difficulties being of all sorts and kinds; one of the principal ones, I believe, consisting of the alleged impracticability of arranging legal titles to ownership, etc.

The unfortunate fact is, sorry as many of us may be to acknowledge it, that the majority of engineers *do not want* to come together in this way, and until they do there is probably little use in urging it upon them. Just why they don't it is difficult to see, as such a scheme is so pre-eminently sensible and profitable to all concerned, from a business point of view, to say nothing of the additional radiance that would glorify the profession in the eyes of foreign engineers and of laymen at home by the possession of the magnificent headquarters, which might easily be arranged for were the 6,000 or 8,000 engineers and architects who are invited to join in the movement to enter into it with spirit.

The idea that rich men would not give because they would not feel sure of their money being wisely and durably expended is not worth a thought; for who doubts that a small commission of good lawyers and engineers could in a few hours formulate a scheme that would allay the fears of the most cautious of millionaires.

As things seem to be going now it will probably be some time—a good way along in the next century—before the lovely ideal that a few of us have so long cherished will become a reality. When it does, New York (unless Chicago gets ahead of her again, and takes it away from her) will see one of the most magnificent buildings in the country, with every convenience and beautiful decoration that the skill and taste of the engineering fraternity can contribute, ornamenting the best part of the city, and containing a splendid assembly hall and all other necessary apartments for its primal purposes, together with the biggest and best engineering library and museum in the world. The surplus room will be occupied not by ordinary "stores," but by offices of engineers, architects, chemists, metallurgists, etc., thus maintaining the character of the building in its full integrity. It must be remembered that a building of this sort would have extensive revenues, which would go a long way toward making it self-supporting.

It may be objected that all this will hardly come to pass after the great societies have spent so much money in buying and building individually. This need not stop the new scheme, however, for real estate can always be sold; and when our engineers shall have once attained the proper spirit of unity and harmony, together with an *esprit de corps* that shall make each one think of himself broadly as an *engineer*, and not as a civil or electrical or naval engineer merely, all that we desire shall come to pass. OBERLIN SMITH.

ALTERNATING CURRENT ELECTRIC RAILWAYS.

Editor AMERICAN ENGINEER AND RAILROAD JOURNAL:

IT has recently been given out that the Allentown & Reading Electric Railway Company intend to build somewhat extensive electric railroads in Pennsylvania and to operate the system by means of alternating currents. If these intentions of the company are carried out, this will be the first practical alternating-current road in existence, and engineers will await with interest the result.

To many engineers this step will indicate that the process of evolution in electric railroading which they have long been expecting has at last begun. It would seem to many that in this case, as in some others, inventors, in attempting to solve the problem, have hit upon a method not the best, and that subsequent inventors have for a long time followed in the original footsteps, improving, but making no radical changes for the better.

There certainly is no application of electricity in the arts to-day more eminently suited to alternating currents than is the electric railway. The problems that alternating-current railways present are surely no more difficult of solution than those presented years ago to the engineers who perfected the present system.

Almost simultaneously with the announcement of the proposed road a paper is read before the American Institute of Electrical Engineers by Mr. Charles S. Bradley on Phasing Transformers. This will undoubtedly prove of the greatest value in the ultimate solution of the problem.

A brief review of the difficulties to be encountered and the advantages to be gained by the use of alternating currents for electric railways will, perhaps, not be out of place at this time.

Considering the two systems in general, we find that the alternating system, if it can be successfully employed, offers immense advantages in simplicity and cheapness both in the original cost of apparatus and in its operation. It can also be employed with greater safety to life and property, and gives rise to no such troubles as electrolysis of water and gas pipes.

All dynamo electric machines are alike in this respect, that the currents that are generated in their armature conductors are alternating, no matter whether the machine as a whole is adapted for continuous or alternate current working. It is therefore necessary, in order to produce a machine generating continuous currents, to add a complication in the shape of a commutator for rectifying the alternating currents of the armature. Now, it is a well-known fact that the commutators of large dynamos are exceedingly difficult and expensive to construct, and in the operation of the machine it is the commutator almost exclusively that occupies the attention of the attendant. It will thus be seen that not only is the initial expense of commutating machines far in excess of alternators, but the expense of operating is also considerably greater by reason of the extra attention necessary, the frequent need of brush renewals, and because the power wasted in brush friction and drop of potential at the brush contacts may in a large station amount to a very considerable yearly item.

On the other hand, it may be urged that most of our alternating-current machines have commutators also in addition to collecting rings. That is very true, but commutators and collectors are by no means necessary in the design of a good alternator. At present most manufacturers make use of them either because they are convenient or in order to avoid conflicting with present patents. Alternating-current generators can be bought to-day of thoroughly reliable manufacturers, and be possessed not only of no commutators or moving contacts, but which have no moving wire as well. What could be more simple than a generator whose only moving part is a mass of laminated iron turning about self-oiling bearings? Such a device will evidently call for the minimum initial expenditure as well as the minimum expense of operating.

Passing from the generating plant to the feeders, we find that with the continuous current system we are not permitted to maintain a voltage much above 500 by reason of the danger to life. Were this barrier removed, we would find that it is impossible to build a successful commutating machine for high voltages. This means that for operating a large system the current is necessarily very great, and the feeders, consequently, very large. If the road is long, we are under the necessity of dividing the generating plant into sections located along the route on account of the large loss of power in long feeders. In any case, the generators must be overcompounded to a considerable degree in order to keep the voltage at the trolley reasonably constant.

In view of these considerations, we readily see: 1. An enormous outlay is necessary for copper. 2. The generating plant will be more expensive to install and operate than if it were all contained in one building. 3. The generators must be operated part of the day, at least, with a low efficiency and consequently large expense.

Granting for the moment that the system can be operated by alternating currents without altering the existing lines, we find that we immediately have an immense advantage. The gain will be threefold. The loss of power in the transmission lines and, consequently, the expense of operating may be greatly decreased. The initial expense of installing the line, and, therefore, the fixed annual charges for interest is much less. A practically uniform voltage may be maintained upon the trolley, and this can be made as small as desirable without greatly increasing the expense, either of operating or installing. All this may be accomplished with extreme simplicity.

The generators, being without commutators or sliding contacts, may be built to deliver a very high voltage, say 10,000, to the lines without danger to the attendant or apparatus. Such machines are now actually built and guaranteed by the manufacturers. With 10,000 volts instead of 500 the current necessary in order to deliver the same amount of energy to the lines will be only one-twentieth of its former amount. As the loss of power in the lines at any instant is C^2R, it is evident that by using the same set of feeders we may decrease our transmission loss by this means to one-four hundredth of its present value.

At the present time it is probably this transmission loss more than any other thing that has thus far made very long electric railways a practical impossibility. It is impossible to employ very high voltages with the continuous current system, owing to the impossibility of using commutating machines. A combination system might be employed in some cases to-day with advantage, using a high voltage alternating transmission and transforming by the use of rotary converters into a low pressure continuous current for supplying the trolley. Such a system has the disadvantage that an attendant will be required to operate each converter, it being moving machinery and constituting in effect a small sub-station. Such converters are also far more expensive to construct and operate than the stationary transformer, and it is obvious that the method is at best a makeshift, and that the pure alternating-current system will prove the ultimate method of operating such lines.

In using a pure alternating system, we must remember, however, to deduct from the apparent gain we noticed above a small amount representing the losses in the necessary transformers, because in this case, as well as in the use of continuous currents, a high voltage in the trolley is not permissible. It should also be mentioned that if the road is very long the transformers along it can be wound in a progressively changing ratio which will compensate for the drop of potential in the primary mains, and keep a practically uniform pressure on the trolley from end to end of the route.

But we have yet to prove that the present lines *can* be employed for operating a pure alternating current system, for, as yet, nothing has been said concerning the car equipment. That is the only difficult feature of the problem as it stands to-day, and engineers have long been familiar with the considerations outlined above. It is in the motor, however, that the alternating system *should* especially outclass its rival, and it is the motor that has thus far given the greatest trouble to electric railroad men.

The alternating current motor of to-day is unsuited for railroad purposes for two reasons. First, it is not very efficient unless running at constant speed. Second, it is not self-starting unless wound for two or more phases, which would necessitate, for railroad use, the employment of at least two trolley wires. This can hardly be allowed except for conduit roads. Otherwise, the alternating motor fulfils to a nicety every requirement of a perfect railway motor. It has no commutator or brushes, and nothing to replace or get out of order. Its armature, being simply a mass of iron and copper with no insulation whatever, has nothing to burn out. If properly built, it is capable of running perfectly, if need be, under water, and perhaps most important of all, it is universally acknowledged to be the cheapest and most reliable motor that can be produced.

Neither of the objections mentioned seem serious, and un-

doubtedly will be perfectly removed before long. For instance, it seems to the writer that the first can be satisfactorily met by the use of some form of flexible gearing, such as hydraulic gearing. This will allow the motor to run at all times at a constant speed and high efficiency, even if the car is standing still. These devices have been described in the technical journals, so that it will not be necessary to discuss them here. The necessity of employing such a system is not an objection, for some of them offer actual positive advantages over the rigidly connected motor. A solution of the second difficulty could probably be found in the use of "phasing transformers" placed upon the car, using perhaps the form described by Mr. Bradley in his paper mentioned at the beginning of this article. By this means the single-phase current from the trolley can be converted into a three-phase current, and an ordinary three-phase motor be made use of.

Other systems could undoubtedly be arranged with the apparatus we have at hand, and many unperfected forms are in the minds of engineers to-day. The writer himself can even imagine a road employing no trolley connections whatever, but making use of some of the many effects of induction which alternating currents give us.

Thus we have an alternating-current railway that could be operated to-day perfectly upon the tracks of the present companies with no change outside the power station except the installation of a few transformers and the more careful insulation of the line. The system may not be the best, or even practicable, but is perfectly possible if occasion required it. The next few years will undoubtedly develop changes and perfections in alternating apparatus that will make the alternating-current railway all that could be desired.

ARTHUR J. FARNSWORTH, S.B.

MINIATURE WAR VESSELS.

A WARSHIP in miniature is being built at the Washington Navy Yard. Though only 5 ft. long, it is a perfect likeness of the *Columbia*, Uncle Sam's fighting ocean greyhound. Every detail is reproduced with the utmost accuracy on a scale of a quarter of an inch to the foot, even the guns being perfect in all of their parts, down to the very breech mechanism.

In the new navy of the United States several classes of vessels are comprised. The Government has adopted the policy of constructing one small model to represent each type of warship in the service. Thus miniature copies have been made of the armored battleship *Texas*, the monitor *Miantonomoh*, the ram *Katahdin*, and others. Seven men at the Washington Navy Yard are constantly employed in building these models, which cost from $2,000 to $8,000 apiece. These artisans are mechanics of the highest skill, and the work they do is such as to require a special training. Workmanship of the utmost difficulty is needed, many of the parts being so little that an ordinary person could not handle them or put them together. Everything must be reproduced, down to the smallest block for the running rigging.

Take the guns of the miniature *Columbia*, for example. They are the prettiest toys imaginable. The big ones, representing originals of 8-in. calibre, are about 4 in. long. No part of either gun or carriage is lacking, and the breech can be opened by a touch of the finger to admit a small-sized armor-piercing projectile or an explosive shell. The secondary batteries of the *Columbia* consist of a number of small machine guns and rapid-fire guns, some of which are aloft in the military tops. Every one is reproduced on its scale in the model.

The building of the model of the *Columbia* was begun by taking a number of pine boards, cut roughly to the outlines of the ship, and putting them together under pressure with glue between them. Thus a solid block of approximate dimensions was formed. The block was then planed and chiselled until the lines of the great war vessel were reproduced with absolute exactness. The hull being made smooth with sandpaper, the rudder and propeller shafts, of cherry wood, were added. At the same time were put on the "sponsons," out of which the guns look as from windows of steel. Holes having been bored for the window ports, the little craft was ready to receive its armament.

The model is not yet finished, but the guns are made and nearly all of the other equipments are ready to be put aboard. These latter are very elaborate, and to produce them has required an immense amount of labor. For example, there are a number of boats, including one steam launch in miniature. Each of these represents three days' work for one man. The false bottoms and every rib inside of them are shown. All of them are of wood, save for the smokestack and rudder of the steam launch. The boats are swung from davits, the tiny metal blocks through which the tackle runs being perfectly practical and just like real ones.

The smokestack of the miniature *Columbia* is of brass, painted just like that of the cruiser herself. Attached to it are escape pipes of copper and a whistle and fog horn, otherwise known as a "steam siren," of nickel silver. The ventilators are of copper. They turn their gaping mouths to the wind, which blows down into them and keeps the air fresh below. One of the last things done is to put the masts into the little ship. They are of wood, but, being painted, they look just like the hollow steel masts of a war vessel. The bigger spars on a war ship are steel tubes. The rigging of the model is of white wire twisted to imitate the wire rigging on a man-o'-war. In the model of a battleship the armor is represented by wood painted.

The models of warships are built in what is called the ship house at the Navy Yard. The establishment is a huge machine shop, under the control of the Construction Bureau of the Navy Department. The miniature vessels are made from the original plans and drawings for cruisers and battleships, which are reduced to scale for the purpose. The object of building the models is to show the people what Uncle Sam's new navy is like. Several of the models have been sent to Atlanta, where they will be viewed by millions. Occasionally models have been sent by the Navy Department to the capitol, in order that congressmen might see them and know what sort of ships they were appropriating money to construct.

In the ship house at the Washington Navy Yard is now being made a model of the battleship *Indiana*, 20 ft. long. It is intended, not for exhibition, but for a more practical purpose. It is of wood, covered with an even coat of paraffine 1 in. thick. When it is finished it will be run on the Potomac River, with an engine inside of it and paddle-wheels. Paddle-wheels are preferred to a propeller, because the power exerted by them can be measured more accurately. This is exactly what is desired to be ascertained—namely, how much power is required to propel the model through the water at a given rate of speed. What is true of the model ought to be true also of the *Indiana*, the form of the hull of the latter being the same. Paraffine is employed because it is perfectly smooth, and will afford no such resistance as might impair the accuracy of the data obtained by the experiments.

In Great Britain the keel of no new ship of war is laid until trial has been made of a miniature model. For this purpose is used an immense tank, 300 ft. long, 25 ft. wide, and 10 ft. deep, filled with water. Above the tank, and running its entire length, is suspended a platform. On the platform is a track, and along the track a carriage runs. Beneath the carriage floats the model, which is made wholly of paraffine. Of course, paraffine is lighter than water. The carriage tows the model along, and the power used is registered with absolute accuracy by a dynamometer. Thus is learned with exactness the speed at which the war ship represented by the model will steam with a given H.P.

Great Britain, in fact, has several such tanks, and similar ones are used for the purpose by France, Germany, and Italy. Secretary Herbert will try to persuade the next Congress to appropriate money for building a tank of the kind at Washington. The cost of it would be about $150,000. It would be cheap at the price, however, for it would afford a means of testing all models of proposed vessels in future before the contracts for their construction were given out. Thus the Navy Department would know exactly what might be expected of every warship before its keel was laid. In a word, the tank experiments make it easy to determine the best form of ship to attain a certain speed.—*Washington Evening Star.*

Our Sea-Coast Defenceless.—Major-General Miles, commanding the Army, in his annual report says: "The entire Gulf Coast and all the great cities of the Atlantic Coast northward to Philadelphia are entirely without modern guns. With one exception the cities north of New York are in a similar condition to those south of it. Some guns and mortars have been constructed and some shipped to their destination, carriages for them are under construction, and emplacements have been made to a limited extent." He shows that torpedo plants are useless without protective batteries, and that the water in our principal harbors is so deep that light-draft vessels might pass over the torpedo mines without danger.

He says that the recent manœuvres in England have shown that even the powerful British navy is unable to defend the British coast against a foreign fleet; therefore he argues that the main reliance must be upon coast batteries. He wants more high-power guns and a much higher-power "appropriation."

THE MOST ADVANTAGEOUS DIMENSIONS FOR LOCOMOTIVE EXHAUST-PIPES AND SMOKE-STACKS.*

By Inspector Troske.

Prüsmann: A later experimenter in this matter, Prüsmann, the inventor of the conical smoke-stack that has been named after him, must be mentioned. He began his experiments about the end of the year 1860, which was at about the same time as those conducted by Nozo and Geoffroy, but he went into the work so extensively, that they were not completed until the beginning of 1863. His paper was published in *Organ für die Fortschritte des Eisenbahnwesens* in 1865, and in the same year it also appeared in book form, where he gathered together his extensive results that had been reached with so much labor.

In figs. 4, 5, and 8 the experimental apparatus that was used by Prüsmann is shown. Fig. 4 shows the first arrangement that was used. It consists of a cylindrical box only 3.28 in. in diameter, through whose cover the cylindrical stacks having the same outside but varying inside diameters could be slipped, and then held in any desired position by a set screw. The blast-pipe entered through the bottom, and was connected with the boiler by means of a pipe in which a cut-off cock was placed. The opening of this cock could be made anything that was desired by means of a handle fastened to its square stem and moving over a graduated arc, thus permitting of an exact regulation of the blast-pipe pressure. Directly over the bottom of the box, as shown at the left, in fig. 4, there was an opening $1\frac{1}{2}$ in. in diameter, through which the air was drawn in by the suction created in the interior. The vacuum was measured by a water column in the form of a siphon-shaped glass tube, whose connection with the box was packed with a rubber washer, the exact blast-pipe pressure not being obtained, but merely that existing in the boiler, while the experiments were in progress, which was read on a metallic pressure gauge. In his experiments Prüsmann chose only such openings of the cock on the apparatus as would produce a vacuum equal to that prevailing at that time in the current practice on the locomotives of the Hanoverian State Railway—namely, from 6 to 7 in., which was obtained by placing a stack on the experimental apparatus corresponding to that in use upon these locomotives. The nozzle of the blast-pipe had a clear diameter of .32 in., and the seven cylindrical experimental stacks had diameters of about 1.25 in., 1.33 in., 1.5 in., 1.58 in., 2.125 in., 1.7 in., and 1.77 in.

Prüsmann formulated the following conclusions as the result of his experiments:

1. The blast-pipe pressure within the limits of current practice has no influence in determining the proper shape of the stack.
2. The increase of the distance from the bottom of the stack to the top of the blast nozzle is not exactly an equivalent, but as it is increased, of course within certain limits, it is accompanied by a corresponding increase in the height of the vacuum.
3. Of the seven experimental stacks used, the one of the mean diameter of 1.58 in. showed the best results.
4. With a stack of the most efficient diameter, its height should be so adjusted that it stands at least four times the diameter of the blast-pipe above it, in order that this latter may be at a proper distance from the lower end of the stack.
5. For every height above the blast nozzle there is one cross-section of stack that will give the most efficient working.

In order to investigate these latter results which he had obtained, Prüsmann changed his experimental apparatus so that he replaced the solid cover by a movable, open shell, like that shown in fig. 5, that could be fastened in position, and on the upper end of which plates having circular openings of different sizes could be bolted. The diameter of the openings in these plates varied by $\frac{1}{4}$ in. from 1 in. to $2\frac{1}{4}$ in. By changing the shell the 11 plates were set at a greater and greater distance from the blast pipe, varying from 0 to 7.6 in., and in this way the vacuum was measured for 39 different positions. Prüsmann thus obtained 11 series of results with 39 figures in each, which he put together in the form of a table, and in such a way that for each of the 39 positions of the blast-pipe the 11 different vacuums that were obtained formed a horizontal series. In each of the vertical as well as the horizontal series there was one of the highest efficiency.

He drew therefrom the following conclusions:

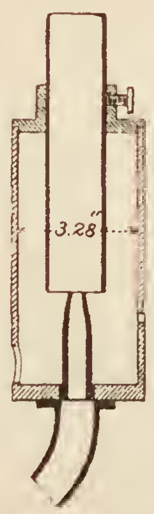
6. For each diameter of opening in the plates there is one distance from the blast-pipe that gives the highest vacuum.
7. The proper form of stack is not a cylinder, but a pipe whose diameter varies with the distance from the blast-pipe.

Now when Prüsmann had laid out the blast-pipe distances already mentioned upon a vertical axis, and had then drawn parallel lines through these points, he then laid out upon each side of the vertical the radius of that plate opening which, for the corresponding distance from the blast-pipe, gave the highest vacuum, and thus obtained a series of circular sections, as indicated in fig. 6, that outlined the general average form of a cone, and from which the conical form of stack was deduced.

Prüsmann made a stack of this shape out of tin, placed it upon the apparatus, and ascertained, by very careful adjustments, that distance of the lower end of the same from the blast-pipe where the highest vacuum was obtained. He then experimented with several tin stacks of similar shape, and finally developed that shown in fig. 7 as being the form that showed the highest efficiency.

It is worthy of note that a cylindrical section was located in the narrowest portion for the sake of avoiding the sharp angle that would otherwise exist between the top and bottom parts, and thus avoid a too rapid widening above and below.

Fig. 4.



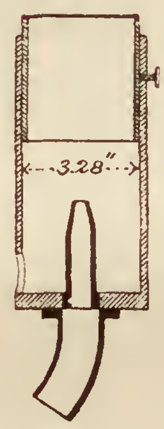


Fig. 5.

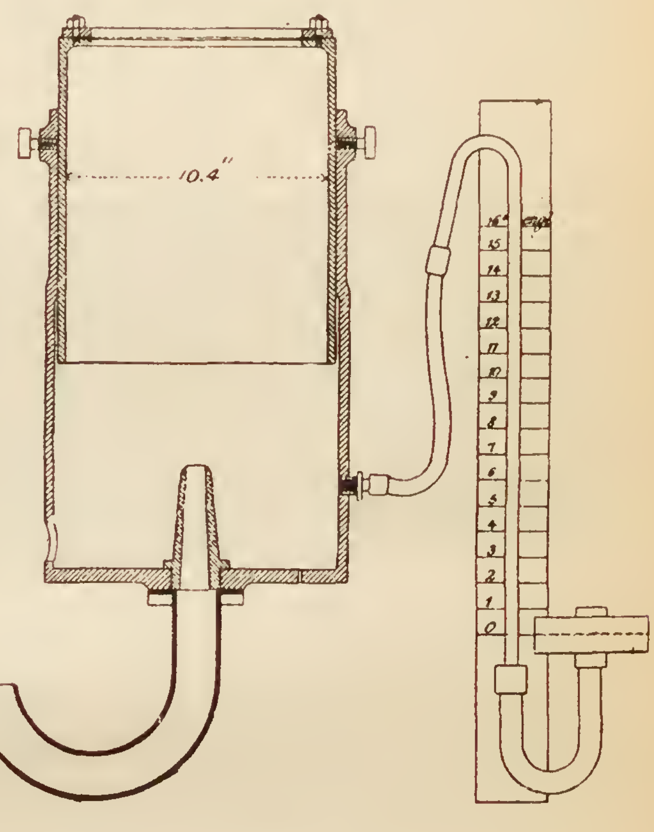


Fig. 8.

Prüsmann then made a stack for a locomotive of exactly this shape, with dimensions proportioned in the ratio of the blast-pipe dimensions of the locomotive to those of the experimental apparatus, which was $\frac{2.79 \text{ in.}}{0.32 \text{ in.}} = 8.594$. The most contracted portion of this stack had a diameter of 11 in., and stood at a height of 27 in. above the top of the nozzle. The locomotive upon which it was placed, and which had formerly made sufficient steam to do its work with a cylindrical stack having a diameter of 15 in., was now found to act in such a way that the exhaust nozzle could be opened .28 in., and an average saving of 23.81 per cent. in the consumption of coal effected, which in some cases arose to as much as 42.2 per cent. On a second locomotive, which had a blast nozzle of about 42.2 per cent. greater diameter, or of $3\frac{3}{8}$ in. diameter, and a conical stack of correspondingly larger dimensions, or $\frac{3.375}{0.32} = 10.547$ times larger than those given in fig. 7, the experiment was a complete failure. "The production of steam was often insufficient, and the coal consumption for the same loads was even increased." From this Prüsmann concluded

* Paper read before the German Society of Mechanical Engineers.

that his method of treatment was a wrong one, in increasing the dimensions of his experimental apparatus in a direct ratio, for it appeared that in the case of the 42.2 per cent. increase in the size of the blast-pipe he had taken it for granted that the grate area had been increased in the same proportion. In order to obtain information upon this point, Prüsmann built a third and larger apparatus. Fig. 8 illustrates this on a scale of one-tenth its actual size. The larger scale, which was attached to the water-gauge, enables more accurate readings to be taken than were possible with the siphon gauge. This third apparatus varies from the two others and also from the

Fig. 6.

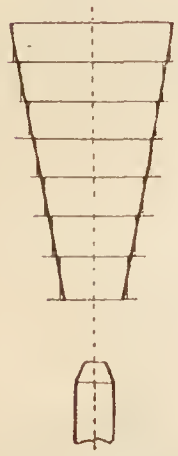
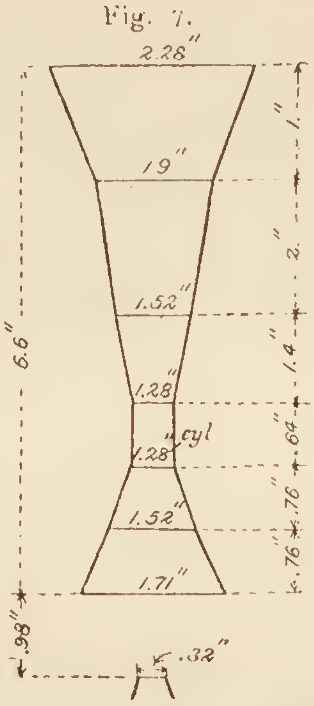
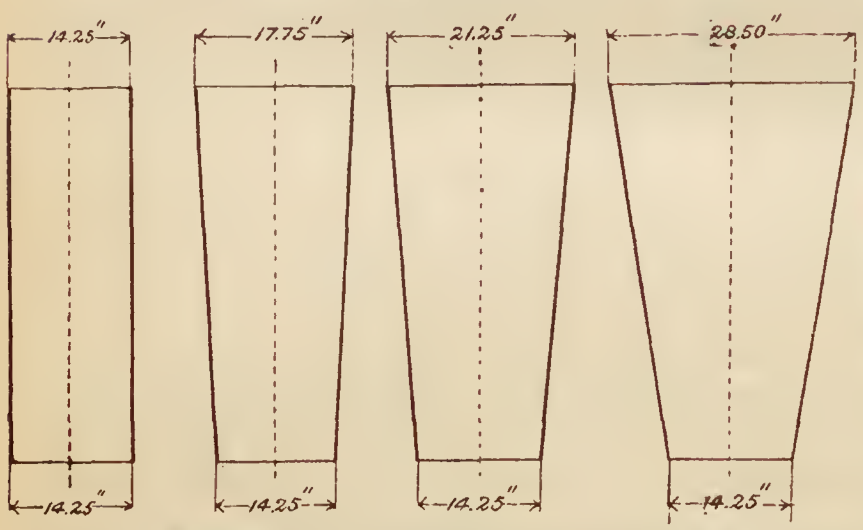


Fig. 7.



apparatus of Zeuner and Nozo in that it had three openings arranged concentrically with the blast-pipe, through which the air that was drawn in entered, and which favored the production of the vacuum. The size of these three openings was ascertained from a locomotive whose wheels and pistons were blocked. The valve was raised and so arranged that with the throttle wide open only so much steam could escape through the blast-pipe by way of the contracted openings in the valve passages, that with the ash-pan damper open, as it usually was while running, a vacuum of 6.8 in. of water was obtained in the smoke-box. Then the ash-pan damper was quickly closed tight, the tube openings into the smoke-box closed as tight as possible with sheet iron, and an air damper

Fig. 9.



in the smoke-box door opened until a vacuum of 6.8 in. was again obtained in the smoke-box. This gave, for coal and coke burning, a free opening equal to the total grate area divided by 21. This ratio was incorporated in the apparatus, and a series of experiments made which also included the use of a nozzle of ¾ in. and one of 1 in. in diameter, with which the height of the stack opening above the same varied from 4½ in. to 25 in. The results obtained were again tested in part with the small experimental stacks, and led to the following conclusions :

8. Making the conicity of the blast-pipe more blunt has a tendency to lower the stack, but, on the other hand, the conicity of the blast-pipe is without any influence upon the distance of the smallest portion of the stack above the nozzle, or upon the diameter of that portion.

9. Under the same circumstances the taper of the shells of stacks remain nearly the same for all locomotives in similar service, provided only that the ratio of the cross-section of the blast-pipe to the grate area remains the same.

10. A stack made for a given blast-pipe must, if all the other ratios remain the same, be enlarged over all by about the difference in the blast-pipe diameters, if we wish to use a larger blast-pipe with this same taper.

11. On non condensing locomotives, whereon it is desired to increase the diameter of the blast-pipe, if the blast-pipe pressure remains the same, the distance of the smallest portion of the stack from the top of the nozzle will be unchanged.

12. The upper portion of the smoke-stack lying above the smallest portion of the same does not consist of a single truncated cone, but of three truncated cones of different inclinations ; these inclinations becoming greater toward the top.

Finally, Prüsmann gave a number of formulæ for calculating the dimensions of stacks and blast-pipes. The one for the location of the blast nozzle taken as t for all locomotives is :

$$t = 2.3673 + 0.857{,}047{,}767\,\delta - 0.136{,}138{,}202\,\delta^2 + 0.525{,}258{,}551\,\delta^3,$$

wherein δ is the diameter of the blast nozzle in inches.

It may, however, be remarked that, though these experiments were carried out so thoroughly and with so much trouble, for in all Prüsmann used 18 different stacks on his apparatus, two of which were similar to those used upon locomotives, and 26 different plate openings, they are not entirely free from objections. Next the dimensions of the experimental apparatus were altogether too small, while the method of measuring the steam pressure was defective. In the first place, the boiler pressure should not have been measured, since it is always liable to a continual shrinkage ; secondly, the boiler used had to supply steam for the shop engine of the works, and then these measurements should not have been taken with a metallic gauge, since it was evidently far from being sensitive enough for a current of steam flowing through an opening of 0.3 in. A quicksilver gauge should have been used in this place, by means of which an accurate measurement could have been made of the pressure existing between the blast nozzle and the controlling cock. By moving the long handle attached to the cock, it would have been easy to have held this pressure at one point. It is to the imperfection of these measurements that we must ascribe the fact that, from the various tables of figures given by Prüsmann, no accurate diagram of exactly what took place can be reproduced ; for if we make a graphic delineation of the values given for a series of experiments, we get in most cases not a regular curve, but a broken line, between whose several parts there are wide variations of direction, and this is especially the case if we refer to Tables I, III, V, XII, and XVII of Prüsmann's work. In the last-named table there are, in several instances, two different values for the vacuum produced by the same position of nozzle, which is evidently impossible if the steam pressure remains the same ; but before all others in inaccuracy is the statement that that plate opening which with a given position of the nozzle gave the best vacuum is the most efficient. This is seen, as a glance at the table teaches, in that the shortest distance is an accompaniment of the smallest opening, while the greatest distance between nozzle and plate is the one belonging to the next to the smallest opening. From which the stack indicated therefrom would evidently be too small. With the stack thus obtained Prüsmann experimented still further, and deduced therefrom each location of blast nozzle from the smallest section of stack under consideration, at which the highest vacuum could be produced. This distance he now took as that at which the highest efficiency could be obtained, and transferred it into terms of the ratio of the diameters of exhaust nozzles upon locomotives ; but such a performance is not at all permissible, as the Hanover experiments clearly show, for these nozzle distances having the strongest action comes out many times as great on many locomotives. If we were to make an application of the Prüsmann formulæ given above to exhaust nozzles of 4 in. or 5 in. in diameter, the distance of these nozzles from the smallest section of the stack would, according to Prüsmann, be 37.8 in. for the first and 70 in. for the second, values that are unheard of in practice. That the Prüsmann stack is above all things too small has long been known. Grove speaks of this in his well-known "Theory of the Blast-Pipe" (1874), and frankly discusses the reason therefor in "The Impossibility of Establishing the Shape of the Stack by Means of the Passage of a Current of Steam through Openings in Thin Plates ;" but, as we have stated above, this is not the principal reason for objecting to the results given.

There are, however, some results which Prüsmann obtained from his experiments, inaccurate as they were in part and

inapplicable as they are to the practice of the present day, which are full of significance for all time, and among them are those that led to the construction and development of the conical stack, which by varying its height above the nozzle within certain limits produces the best vacuum.

Zeuner : A very interesting continuation of the experiments of Prüsmann was commenced a year later by Zeuner, and published in 1871 under the title of "On the Action of the Blast Apparatus of Locomotives with Conical Flaring Stacks."

Unfortunately Zeuner had, as he says in writing of this work, no knowledge of the results which the Prüsmann experiments had yielded, so that he turned to his earlier experiments with cylindrical stacks that were briefly outlined in our last issue, but in other respects the information elicited was that resulting from a purely mathematical calculation. In consequence thereof his theory included not the conical stack, but the location of the blast nozzle and its influence upon the action of the draft ; the length of the stack is also disregarded. He laid down the following principles :

1. For a given diameter of blast-pipe and sectional area through the tubes, there is one most efficient sectional area of stack, measured at the smallest point, with which the maximum draft can be obtained.

2. The vacuum in the smoke-box and the inrush of the mixture of air and gases increases as the flare on the upper end of the stack is increased, but a moderate amount of this flare soon gives an action that is perfectly satisfactory.

The conical stack will admit, for the same draft action, of a large exhaust nozzle opening. For the same train speed, therefore, it gives more power to the locomotive than the cylindrical stack, on account of the decrease of back pressure upon the pistons, which thus increases its mean effective working and lessens the fuel consumption in consequence.

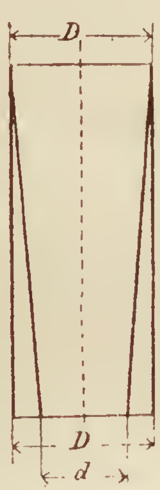


Fig. 10.

Fig. 11.

In its general significance, conclusion No. 1 is not applicable to locomotives ; the same thing may be said here that was remarked above relative to cylindrical stacks.

The results of the Hanover experiments are also at variance with the statement of No. 2. Zeuner reconciled his theories offhand by taking a blast nozzle 3.94 in. in diameter, a cylindrical stack of 14.25 in. diameter with three conical stacks, as shown in fig. 9, all of whose smallest diameters were also 14.25 in., while the upper diameters were 17.75 in., 21.25 in., and 28.5 in. He then calculated that the stack with the widest flare—that is, the one with the upper diameter of 28.5 in.—would draw in the most air with a given amount of steam, the blast nozzle remaining the same, and that it is also the most efficient.

The Hanover experiments, on the other hand, showed that if the upper diameter of all stacks is kept the same, while the lower diameter is varied, the strongest draft and consequently the greatest inflow of air will be obtained with that having the smallest diameter. If we start, as Zeuner did, with equal lower diameters, we find from Tables X and XII, that give a graphical representation of the Hanover experiments, the very reverse to be the case to what Zeuner theoretically maintained.

The third of the Zeuner conclusions that we mentioned above is also not in accord with more recent experiments, for, as I shall show later on, the conical stacks are not superior to the straight stacks in inducing draft. Both forms, if properly proportioned, therefore admit of the use of the same diameter of blast-pipe for the production of the same vacuum.

Grove : We come now to the mention of Grove as the last to pursue this line of investigation. In a handbook compiled by Heusinger von Waldegg on special railroad technical work, he has handled the difficult question of the blast-pipe in a very lucid manner, has advanced some excellent theories, especially with reference to the position of the blast nozzle with reference both to cylindrical and conical stacks. His formulæ are especially valuable for locomotives with small grate areas, but for those having larger areas the calculated dimensions are too small.

In his theory Grove followed in the footsteps of Zeuner relative to the action of the draft, and also advocated the superiority of the conical stack. In paragraph X, that has been already referred to, this comparison is pointed out offhand, and that in connection with the sectional area of the tubes and not with the grate area, whereby the error is called forth. The tradition regarding the superiority of the conical stack is referable to Prüsmann. He compared a cylindrical stack, which was evidently too large with reference to the blast nozzle, as shown in fig. 11, with a conical one whose dimensions were too small. The former had a diameter of 15 in., and the latter was 11 in. at the waist. The result was that, with the first, the blast nozzle was flush with the bottom of the stack, while, with the conical stack, it was placed 27 in. below that point. Had Prüsmann contracted the cylindrical stack correspondingly and then lowered the blast-pipe, he would doubtless have obtained the same improvement in the action of the draft on his locomotive as he did obtain by the application of his small conical stack.

This demonstration of the equality of the two forms of stacks is one of the important achievements of the Hanover experiments.

(TO BE CONTINUED.)

THE UNITED STATES BATTLESHIP "INDIANA."

THE *Indiana*, one of the three coast-line battleships authorized by the act of Congress approved June 30, 1890, making an appropriation for the construction of three battleships at an individual cost not to exceed $4,000,000, has just been accepted by the Government and placed in commission. The contract for the construction of this vessel was awarded to the William Cramp & Sons Ship & Engine-Building Works, of Philadelphia, Pa. The vessel was launched on February 28, 1893.

The *Indiana* is built of steel. The hull is protected by belts of heavy armor 7½ ft. wide, 3 ft. of which is above water. This protection runs along both sides of the vessel for a distance of 148 ft. amidships, at the extremities of which the armor turns in toward the centre line at an angle of 45° for a longitudinal distance of 24 ft., affording a total broadside protection of 196 ft., and passing around and supporting the armor for the 13-in. gun turrets. On top of this side armor is placed a steel deck 2¾ in. thick, under which are the magazines and machinery. Above this belt of side armor, and extending from redoubt to redoubt, the sides are 5 in. thick with a backing of 10 ft. of coal.

The vessel is cut up forward beneath the water-line, making a powerful ram bow, and doing away with excessive bow waves on account of the easier lines so obtained as well as greatly adding to the manœuvring qualities.

The principal dimensions are :

Length on the water line	348 ft.
Breadth, extreme	69¼ ft.
Draft forward and aft	24 ft.
Displacement	10,288 tons.
Sustained sea-speed	15 knots.
Normal coal supply	400 tons.

Between the turrets for the 13-in. guns there is a superstructure in which are placed the 6-in. guns, and above or upon the deck erected thereon are placed the 8-in. guns. A battery of 6-pdrs. is arranged along the top of the hammock berthing and bridge, and 1-pdrs. are placed two forward and two aft, one on either side on the berth-deck. In the tops of the double-topped military mast are placed four Gatling guns, two in each top.

The main battery consists of four 13-in. breech-loading rifles, eight 8-in. breech-loading rifles and four 6-in. breech-loading rifles. In the secondary battery there are twenty 6-pdr. rapid-fire guns, four 1-pdr. rapid-fire guns and four Gatling guns.

In addition to the foregoing offensive phase of the ship, there are six torpedo-tubes, one bow, one stern, and four broadside, two on either side, just abaft and forward of the forward and after barbettes respectively.

The four 13-in. guns are mounted in pairs in two barbette turrets forward and abaft the superstructure on the main deck. The lower part of these turrets, called the barbette, is 17 in. thick, while the turret proper, which rises above this wall of armor, is 15 in. thick.

The 8-in. guns are mounted in pairs in four turrets of similar character, two on either side, on the forward and after extremities of the superstructure deck.

The four 6-in. guns, two on each side, are placed amidships on the main deck. These guns will have local protection in addition to splinter bulkheads, shields and automatic shutters.

The 13-in. guns have an effective arc of fire of 270°. These guns are mounted about 17½ ft. above the water-line. The 8-in. guns are about 25 ft. above the water-line, and are high

THE UNITED STATES BATTLESHIP "INDIANA," WHILE UNDERGOING THE OFFICIAL SPEED TRIAL OFF CAPE ANN, MASS.

enough to fire over the 13-in. turrets. These guns have a radius of action of 164°.

The engines are of the twin-screw, vertical, triple-expansion, inverted-cylinder type; diameter of cylinders being as follows: high pressure, 34.5 in.; intermediate pressure, 48 in.; low pressure, 75 in., with a common stroke of 42 in. There are four double-ended boilers 18 ft. × 15 ft. in diameter, and two single ended boilers (donkey), 8½ ft. × 10 ft. in diameter. Each boiler and engine is in a separate watertight compartment, in order to localize possible injury.

While the normal coal supply is 400 tons, there is a coal bunker capacity of 1,800 tons.

The complement will consist of 475 persons—officers and men. Good quarters and accommodations have been provided, and all the latest sanitary improvements will be installed to insure efficiency and thoroughness in lighting, ventilating, and draining.

While the *Indiana* was under construction there were innumerable croakers who were ready with all sorts of predictions that the vessel would be so top-heavy that her roll in a seaway would be excessive and dangerous. Great interest was accordingly manifested in her performance on her first trip to sea. On leaving the yard the first run was made to the Delaware Breakwater, where she anchored for the night, to wait for a heavy northeasterly gale to subside. The following morning the vessel put to sea, where, although the gale had abated, there was still a heavy sea running, and all on board were in expectation of being badly pitched and rolled about. Some of the members of the Naval Trial Board got out their instruments for registering the roll of a ship, and were prepared to note the number of degrees. To their surprise the ship rode each wave lightly, and the greatest roll noted and reported was only 1½°.

On October 16 the vessel made a preliminary run over the official course off Cape Ann, Mass., and made an average speed of 15.31 knots over a distance of 62 nautical miles. On this run the absence of the usual vibrations made by the powerful engines of a big ship were particularly noticeable. Another feature was the bow wave cast off by the ship. The torpedo-tube in the bow threw up quite a wave, but the bow of the boat itself cleft cleanly through the water, and the lateral waves, instead of extending many feet on each side of the ship, did not extend much more than 15 ft., and then they converged sharply and clung to the vessel's side, leaving no side wave at all.

The official trial was made on October 18 between Cape Ann and Boone Island. The run to Boone Island was made against the tide in 2 hours 2 minutes and 7 seconds, with an average speed of 15.24 knots. On the return the passage was made in 1 hour 55 minutes and 35 seconds, making a total of 3 hours 58 minutes and 28 seconds for the whole run, or an average speed of 15.61 knots, which was .61 knot above the contract requirements. There was a remarkable burst of speed at the latter end of the run, where a speed of 16.3 knots was attained. At this time 11,800 H.P. were developed. The average H.P. shown during the trial was 9,700, which is 700 more than the contract requirements. The maximum revolutions of the screws were 131, and the average revolutions were between 128 and 130. The average steam pressure at the boilers was 165 and at the engines 161. The average water pressure in the fire-rooms was 1 in. and the average temperature was 105.°

After the run was over a helm test was made. The ship was turned in a circle of 400 yds., or 200 less than it took to turn the cruiser *New York*, and she answered her helm with great promptness.

There are some marked peculiarities in the construction of the engines of this vessel, and in a future issue we expect to publish a very fully illustrated description of them.

MEETING OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

The third general meeting of this Society was held in the rooms of the Society of Mechanical Engineers, No. 12 West Thirty-first Street, New York, on November 7 and 8. Papers were presented on the following subjects: American Maritime Development, by Captain Henry C. Taylor, President of the Naval War College; Performance of the Twin-Screw Steamer *City of Lowell*, by Professor J. E. Denton; Aluminum: Its Alloys, and their Use in Ship Construction, by James C. McGuire; Rudder Experiments—U.S.S. *Monterey*, by Elliot Snow, Assistant Naval Constructor U. S. Navy; Methods and Forms for Certain Ship Calculations, by D. W. Taylor, Naval Constructor U. S. Navy; The Number of Longitudinal Intervals in Ship Computation, as Affecting the Accuracy of Integration for Displacement, by W. F. Durand; Recent Designs for Vessels of the U. S. Navy, by Philip Hichborn, Chief Constructor U. S. Navy; Tactical Considerations Involved in Warship Design, by Lieutenant A. P. Niblack, U. S. Navy; The Centre Board: Its Influence on Design; its Value and its Proper Use, by W. P. Stephens; Engineering Research in the Navy, by Professor William S. Aldrich; Ventilation of Ships, by F. B. Dowst; and An Experimental Test of the Armored Side of U.S.S. *Iowa*, by Albert W. Stahl, Naval Constructor U. S. Navy.

A somewhat interesting episode occurred during the proceedings. In the discussion of Captain Taylor's paper, Rear-Admiral Richard W. Meade (retired) was brought to his feet. He wanted the Society to petition Congress at once to do something for the Nicaragua Canal. That canal was bound to be built, and this country could not contemplate unmoved any possibility of its construction by foreigners. The time had come when this country must "reach out." We wanted San Domingo; we should have had it, and would have had it ere now but for blind politicians. The time had come when the United States should say to "certain parties on the other side of the water" that if there was any land lying around loose on this side the United States was the residuary legatee of that land.

The Society, however, was not prepared to act with precipitation. A committee was appointed, not to memorialize Congress, but to report to the Society its conclusions on the subject of doing so. Rear Admiral Meade (retired) headed the committee, and the remaining members were Thomas W. Hyde, Jacob W. Miller, U. S. Navy (retired), Lewis Nixon, and Charles H. Loring, U. S. Navy (retired).

The next day Rear Admiral Meade made a report, in which he expressed regret that he could not submit a unanimous recommendation from the committee. The majority, however, reported that it was proper and advisable for the Society to memorialize Congress on the subject; and he had prepared a form of memorial which, if there was no objection, he would proceed to read. No ne protesting, the Rear-Admiral read a petition setting forth that the canal would prove an inestimable boon to humanity, but especially to these United States, and that, in the judgment of the Society, its promotion was a task Congress ought to undertake, and was accordingly petitioned to take.

Then it transpired that the minority was represented by Commodore Charles Harding Loring, formerly Chief Engineer of the Navy, a defection from his own profession and his own retirement, whence the real grief displayed by the Rear-Admiral at the lack of unanimity. Commodore Loring said his dissent was not upon the merits of the canal, but for the purpose of protecting the Society from the encroachment of extraneous objects. He feared the Society was proposing to wander off from its legitimate functions. It was established for one purpose—to promote ship-building. There was no warrant for going out of its province, as was proposed. Once done, there was no reason why the society should not be asked to take action concerning the belligerent rights of Cuba, or the annexation of Hawaii, or drawing a line on the north between the British and ourselves. There was some talk about Americanism and patriotism on the part of several who favored the report and memorial, to all of which Commissioner Loring responded from time to time that it was very beautiful, but did not answer his objection that the action proposed was outside the province of the Society. When the decisive vote was taken the report of Rear-Admiral Meade (retired), which had at first been received with apparent favor, judging from the applause, was decisively rejected by a vote of 27 to 14.

THE DOCTEUR BRICK-LINED FIRE-BOX.

From time to time experiments have been made upon the locomotives of European railroads with boilers in which the fire-boxes were lined with fire-brick, and the sole heating surface was that of the tubes, the water legs being dispensed with. In the tests that have been made, it almost invariably appeared that the evaporative efficiency of the boilers was fully equal to that of the standard construction, due probably to the more perfect combustion in the fire-box and the higher temperature of the gases entering the tubes with the resulting higher efficiency of the same. In our issue for September, 1893, we published a description of the Bork boiler which had a fire-box of this type, and with which an evaporative efficiency slightly in excess of that of the standard boi'er was obtained. The most recent attempt in this direction has been made by M. Docteur on the Belgian State Railways, for the particulars of which we are indebted to the *Revue Industrielle*.

The Belgian State Railway has recently resumed the use of red copper tubes and coal; and tubes of this character seem to be giving satisfactory results. Also the red copper tube sheets in the smoke-boxes appear to act very well in service. But

the high price of the materials added very materially to the expense of making the boilers, the value of the worn-out plates not being a sufficient compensation for the capital invested.

It was to avoid this increase of expense that M. Docteur has endeavored to design a boiler for the least possible expense, while still preserving the red copper tube sheet in the fire-box and using the coal that the other boilers use. To do this, he has made the sides and back of the fire-box of a refractory material. It was to be feared that the design would receive a set back from the fact that it does away with almost the whole of the direct heating surface, and thus reduces the evaporating surface, which is thus confined to the crown-sheet. But experience has shown that the fears entertained as to the second point have been without any foundation whatever.

To equalize the partial suppression of the direct heating surface, the diameter of the shell of the boiler is increased, so that the number of tubes might be increased. With this provision 306 tubes are put in a boiler of this type. The excess of heating surface thus obtained permitted a number of tubes to be blocked without any injury to the regularity of the service, for the purpose of ascertaining whether or no the direct heating surface really possesses the importance that has been attributed to it. For the sake of equalizing the cutting down of the steam space due to the abandonment of the outer shell of the fire-box, M. Docteur has placed a steam-drum on top of the boiler near the front end. The volume of this drum exceeds by 25 cub. ft. the combined space in an ordinary boiler of the dome, and that above the crown-sheet in the cylindrical portion.

more influence in the production of steam than the same amount of surface in the tubes. This, at least, is what M. Docteur claims in a communication which he has made to the Association of Engineers of the Liège School, and from which the facts contained in this article are obtained.

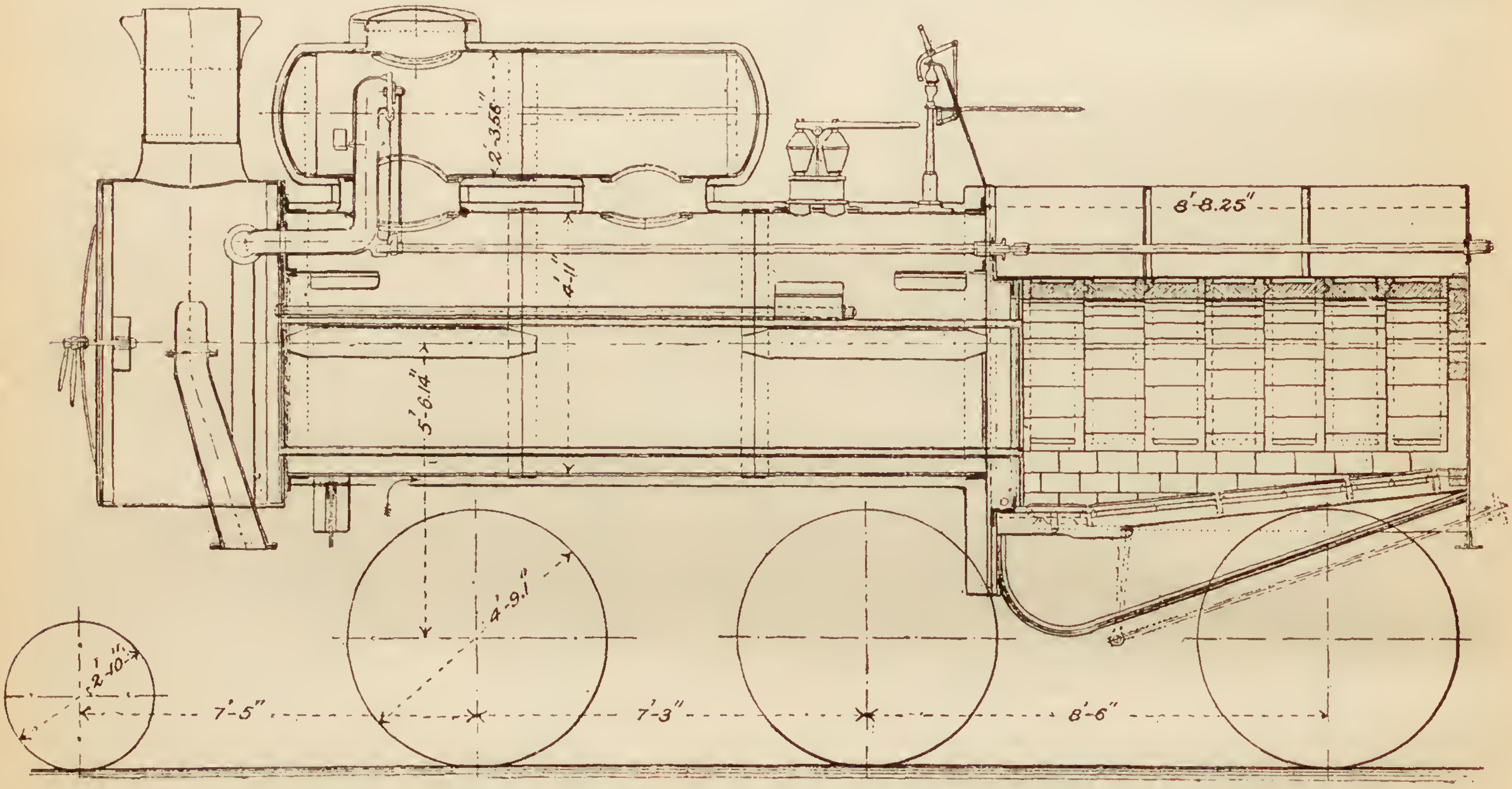
The test of the new fire-box with fire-brick walls was made on locomotive No. 512, with outside cylinders, and of which the following are the main dimensions :

Diameter of cylinders	19 1 in.
Stroke of piston	26 in.
Steam pressure	142 lbs. per sq. in.
Diameter of driving-wheels	4 ft. 11.45 in.

This locomotive has been in service since February, 1894, hauling trains of the regular weight and length. The several tests that have been made with the new boiler have given very satisfactory results from the standpoint of the evaporation of water, which has risen to as much as 8½ to 9 lbs. of water per pound of coal burned while hauling through trains with a light load.

It was also found that the combustion of the coal in the fire-box was perfect—a result that is undoubtedly due, in the first place, to the high temperature which is maintained in the fire-box, whose walls are not continually cooled by contact with water, as is the case in the ordinary boiler ; and, secondly, to the fact that the hot air admitted above the coal burning upon the grate is sufficient to burn all of the gases that are set free by the heat of this combustion.

On being thrown into the fire-box the coal is at once raised to such a temperature that it becomes incandescent, and its



LOCOMOTIVE ON THE BELGIAN STATE RAILWAY, WITH DOCTEUR'S BRICK-LINED FIRE-BOX.

This steam drum has openings and a man-hole through which the boiler can be inspected and access be obtained to the throttle valve and dry pipe.

The accompanying illustration gives a clear idea of the assembled arrangement of a locomotive provided with this new boiler.

It was of importance to ascertain whether a fire-brick wall would stand in the fire-box of a locomotive, and learn the durability of such walls, as well as to insure the efficiency of the circulation of air between the bricks that must be maintained, not only for cooling them, but also for admitting hot air above the grates. The heating surface reduced by about 30 per cent. relatively to that of an ordinary boiler has been recognized as sufficient to demonstrate the principle ; and the steam produced has always been at least as dry as that of ordinary boilers.

The results obtained prove that it is sufficient to increase the indirect heating surface by an amount equivalent to the amount of direct heating surface suppressed, in order to obtain a production of steam at least equal to that obtained with the same total of direct and indirect surface ; in fact, by plugging tubes until the heating surface was reduced to that of the old locomotive, the operation of the engine was in no way affected. Hence 1 sq. ft. of direct heating surface has no

gases are not distilled as in other fire-boxes. The temperature of the gases upon reaching the smoke-box is never more than 720° F. at a few inches from the tube-sheet, as in the best locomotives used in freight service. The cinders deposited in the smoke-box are far less in quantity than are found in the ordinary boilers, and they are also very much smaller and cooler. The production of carbonic oxide is avoided ; the flames developed in the fire-box are clear and well defined ; the production of heat is great, yet the loss of heat due to radiation around the fire-box is slight on account of the fire-brick lining, which has a thickness of 4 in., and of the current of air passing between the bricks ; and finally the sheet-iron jacketing that is laid directly against the fire-brick has a lower temperature than that of the jacketing on an ordinary boiler.

The admission of the air which circulates between the two casings in the arch of the double wall effects a perfect smoke consumption or smoke prevention, regardless of the quality of the coal that is used ; thus, the new fire-box has been stoked with the Flénu coal for welding furnaces, with pure semi-bituminous coals, with a mixture of semi-bituminous and hard coal, and, in all of these tests, it has been impossible to detect any difference in the color of the smoke. It has been possible, furthermore, to feed the new fire-box with a mixture composed of 75 per cent. of hard coal and 25 per cent. of coking coal ;

under these conditions a very high evaporation was obtained, averaging 8 lbs. of water per pound of coal; in some cases it rose as high as 8.5 lbs. to 9 lbs. of water per pound of coal consumed; and in hauling through freight trains, where the fire-box was always at work, the evaporation was higher than 9 lbs.

While the fuel consumption of the same locomotive, with its old boiler, fired with good coal, was always more than 77 lbs. per mile, it has dropped, with this new boiler, to 54.2 lbs. on an average over a measured run of 11,625 miles.

The new fire-box has another advantage: it has been possible to reduce the draft up through the bed of coal on account of the draft of hot air which enters through the spaces left between the brick in the walls, and which enters the fire-box over the top of the coal. The consequence is that the coal is not drawn into the smoke-box, and that it is possible to use and even give the preference to light and hard coals.

Two series of tests have been made with this boiler; the first related to the consumption of fuel and water. On averaging 16 experimental runs, it was found that 7.7 lbs. of water were evaporated per pound of coal burned.

In the second series, the total work done by the locomotive was measured; the consumption of coal during the interval was taken into consideration, and finally an allowance of fuel was made to the engine for the work performed. The following are the results obtained:

Distance Run in Miles.	Virtual Units Hauled.	Consumption of Coal in Lbs.			Allowance of Fuel Made in lbs.
		Bituminous.	Hard.	Total.	
210.65	25,984	3,528	6,615	10,143	17,223
908.46	119,888	18,960	36.162	55,122	73,749
531.28	68,776	6,615	21,160	27,775	39,038
1650.39	214,648	29,103	63,937	93,040	130,010

It will be seen from these figures that the consumption of coal per mile run was about 56.38 lbs., or .43 lbs. per virtual unit hauled, which shows a saving in the total consumption of 36,970 lbs., or 33 per cent.

M. Docteur says that he is very well satisfied; and in view of the unfavorable results that were given by the same locomotive with its old boiler, he is disposed to attribute the improvement that has made itself manifest solely to the fortunate change in the boiler—that is to say, to the new type of fire-box.

Experiments were also made in order to ascertain how many square feet of indirect heating surface in the tubes would be required to replace 1 sq. ft. of direct surface in the fire-box. For this purpose, 20, 39, 51, 67, 76, and 100 tubes were successively plugged. With 20 tubes plugged, an average of four tests showed an evaporation of 8.28 lbs. per pound of coal; with 39 tubes plugged, this average was 8.2 lbs.; it dropped to 7.89 lbs. with 51 tubes plugged. Starting from this point, no further measurements of the consumption were made; but with 76 tubes plugged the boiler still furnished sufficient steam to haul the regular trains assigned to the freight locomotives on the run. This was the limit, however, for with the plugging of a greater number of tubes the steam pressure could not be maintained.

The heating surface of the boiler, before the tubes were plugged, was 15.6 sq. ft. in the fire-box and 1,707 sq. ft. in the tubes, or a total of 1,722.6 sq. ft. After 76 tubes had been plugged, the heating surface remained at 15.6 sq. ft. in the fire-box, and was reduced to 1,285.35 sq. ft. in the tubes, or a total of 1,300.95 sq. ft. These figures practically agree with the total heating surface in the locomotives of the Belgian State Railway known as type 25, which is 1,299.38 sq. ft., with 122.06 sq. ft. in the fire-box and 1,177.32 sq. ft. in the tubes.

We are, therefore, at liberty to conclude that the difference in the production of steam between the direct and indirect heating surfaces is very slight in a locomotive boiler.

Finally, tests were made in which there was no admission of air through the walls; and here it was shown that there was an immediate falling off in the production of steam, an increase in the consumption of coal, and a less perfect combustion.

The use of refractory materials for the fire-boxes of tubular boilers requires great care. It is essential that all admission of cold air should be cut off when the bricks are heated to a white heat, and that the fire should not be drawn immediately after the engine is housed, for the fire should be allowed to die out gradually upon the grate. By acting in this way the pressure can be held for several hours.

Steam has always been generated in this boiler, even from cold water, in an hour and a half at the outside, whereas it ordinarily requires at least three hours. The expansion of the shell has been very accurately measured by means of marks on the frame, and it has never exceeded .16 in. to .2 in.

These considerations have led M. Docteur to conclude that this boiler is absolutely safe; and that, furthermore, it will allow of a very important saving in the invested capital, as compared with the ordinary boiler on a freight locomotive which is of essentially the same dimensions; this saving being placed at 5,000 francs ($965).

The expense for the complete renewal of the fire-brick walls, including material and labor, will not exceed 100 francs ($19.30), and the work can be done by an ordinary mason. It should be noted that the cost of replacing a few stay-bolts of an ordinary boiler would exceed this amount. The use of this new style of boiler is expected to render it possible to effect a saving in fuel of from 10 to 12 per cent. by the admission of air above the grate.

ELECTRICAL NOTES.

The main question concerning traction systems in cities is the cost of power supply, and this is not always cheapest by the electrical plan unless the lines are so long as to render a cable system prohibitive. Another argument of growing importance is that modern requirements in large cities demand a rate of speed that the horse is not equal to.

Of all systems tried on a large scale, the cable is cheapest to run up to a certain distance. We can get more work done by hauling a load with a rope than any other way, provided only that the rope is not too long, in which case it costs too much to pull the rope alone without any car containing passengers attached to it. That is what places a limit to the economical operation of cable systems; they are cheaper for short distances, but cost more than electricity for long distances that require several cable plants.

The story of 10 years' progress in electric traction is quite as interestng as that of any single marvel the new agent has produced; and if electricity does not come out ahead in the long run, it will at least have served the purpose of driving every other system to do its best, and of driving absolute systems out of existence. A great promoter of the principle of the survival of the fittest is electricity.

There will always be unquestioned advantages in any system in which the vehicle is independent of other vehicles along the route or of a central station. This feature doubtless more than any other has been the means of drawing millions of dollars into investment in the storage battery, with no better result to-day than a system that requires about two tons of lead to haul one ton of passengers. The independent vehicle will always remain the ideal plan.

We find the distance up to which a single cable is operative is quite small when compared with that over which we can operate a trolley system from a single former station. This is one advantage of trolley systems over cable systems, and another not less important one is the fact that the overhead trolley wire and support cost very much less than the cable and its conduit per mile.

Both cable and trolley systems are open alike to the serious objection of not having an independent self-propelling vehicle. Any system free from this defect will make a strong bid for public favor, and with certainty of success if the cost is not too high. With storage systems, which alone offer this advantage, the cost is too high, and in the present state of the art this unfortunate defect seems to be without remedy. As for the horse, he costs just about as much as the storage battery to run, and is just about as dirty and troublesome.

In respect to its traction systems, New York is singularly behind other large cities in adopting the latest improvements; but this seems to be the result of conditions that strangely justify her course. Thus, the elevated system of New York City was brought to completion long before the perfection of the electric car motor. When the electric car first came on the scene, the elevated in New York had been long completed on all the avenues on which it now runs, and steam became the motive power by mere accident of time.

One new departure from cable practice has been made by the Metropolitan Traction Company, of New York. Within the current year they have ventured the trial of an under-

ground trolley line for a few miles on Lenox Avenue, and it has given satisfactory results thus far ; the severity of winter is, however, the crucial test that will determine its staying powers.

Out of the many good systems offered this company, the one laid down was selected, it seems, for the reason that if it failed to work satisfactorily—and it probably will in time—it can be taken up without great loss and a cable laid in its place, the conduit being equally well adapted to both systems—in fact, the system seems to have been put down with failure in anticipation. The same system was a failure in Chicago ; it was tried in Washington, and failed there. Let us hope for a surprise in New York. It is almost identical in principle and construction with the Buda-Pesth system, so long in use there under much better conditions of climate. It has not yet shown itself equal to the rigors of a Northern winter in the States. There are numerous underground trolley systems that surpass it in reliability and certainty of action, and numerous systems that require no slot are far superior to it. In the Lenox Avenue system the voltage used is only 300, and the current is taken from two bare copper wires that extend from end to end of the conduit, less than a foot apart. If anything bridges these wires that will conduct the current at the voltage used, then serious trouble will follow. Normally the current goes from one lead to the other only through the motor on the car, and it will go that way and do its work propelling the car as long as there is no easier path for it ; but a most persistent feature of electricity is that it seems to be always looking for some other path than the one intended ; give it half a chance, and it finds the other way to a moral certainty. Some day the conduit will fill with water or slush, which will bridge the two wires, and the electric current won't wait another instant. Strange to say, among the comparatively few electric roads in Europe, 50 per cent. or more of them are underground trolley systems.

Electric Locomotives.—It is announced that the Baldwin Locomotive Works have received orders for a number of electric locomotives for passenger train service, and are at present building two freight locomotives designed to haul trains of 800 tons. Two of the freight locomotives, it is reported, are for the Westinghouse Company, to be used for switching purposes in their yard at Pittsburgh.

Stationary Electric Motors.—From statistics of the United States Electric Census of 1890, which has but recently appeared, it seems that in that year there were 2,363 stationary electric motors in use in the State of New York. These machines, all supplied from central stations, aggregate about 3,000 H.P. Of the entire number, 668 were run on a metre service, and yielded a return of $67,550, while 1,695 were supplied with current by contract, yielding $117,655.

Elevated Electric Railroad.—A company has applied to the New York Railroad Commissioners for permission to construct an elevated electric railroad through Long Island. The bicycle road recently in operation at Bellport, L. I., is to be practically the model of the proposed road. The rate of speed on the road is to be from 50 to 65 miles an hour. In answer to a question by Mr. Kelly, Mr. Denton, the president of the petitioning company, said that some time the company expected to run its cars at a speed of 100 miles an hour !

St. Louis likely to Have an Electric Conduit Railway System.—Wherein lies the good judgment or discretion of putting down an electric conduit railway system of questionable merit, and certainly not the best, simply because it offers peculiar facilities for changing over to the cable in case of failure ? When will this anticipation and expectation of failure end ? With the many good systems available, this practice should be at an end now, but it is not. On the new Third Avenue Line the old "Love system"—not unlike that on Lenox Avenue—is going down, and now comes news from St. Louis that a similar system is likely to be selected for a new line in that city ; this, however, we are given to understand, is contingent upon the Washington system standing the test of the present winter successfully.

Incandescent Light Patent.—It was announced in the daily papers that on November 11 the Supreme Court of the United States, in an opinion read by Justice Brown, in Washington, sustained the Edison incandescent light patent against the claim of the Consolidated Electric Light Company, using the Sawyer-Mann system, of which it was claimed that the Edison system was an infringement. The case came from the United States Court for the Western District of Pennsylvania, which gave judgment in favor of the Edison company.

The court below decided, first, that the Sawyer Mann patent was invalid because of amendments to the application, which made it in effect a new application ; and, second, that the priority of invention was with Edison, the experiments of Sawyer and Mann never having resulted in a successful system of lighting.

The second point, Justice Brown said, had not been considered by the court, because the conclusion on the first disposed of the case. It was their opinion that the claim of a conductor composed of carbonized fibrous and textile material is too broad to sustain the patent, and it must therefore be declared invalid. They could not by such a claim shut out all other investigators into the field of vegetable fibre. As a matter of fact, the justice said, Sawyer and Mann had confined their experiments to carbonized fibre and charcoal. Edison and his assistants had examined 6,000 articles in their search, and finally fixed upon the cuticle of a species of bamboo as the best thing for the conductor. Sawyer and Mann abandoned the materials they had used in their early experiments, and had adopted the material used by Edison. Yet they claimed that their patent was broad enough to exclude Edison's material and make his use of it an infringement. This could not be sustained, said Justice Brown : the claim was entirely too broad. The Sawyer and Mann patent was, therefore, invalid, and the judgment of the court below to that effect was affirmed.

The result of this decision, it is said, is to throw open both systems to the public. The Sawyer-Mann patent is invalid, and the Edison patent expired, by a coincidence, just a year ago to-day, under the operation of the decision in the Bate refrigerating patent case.

Underground Trolley Roads.—The coming year bids fair to bring considerable development of underground systems. Just as we go to press information is received of the decision of the Metropolitan Traction Company, of New York City, to lay a trial piece of track equipped with the Johnson-Lundell sectional midrail system, the successful working of which will undoubtedly insure the adoption of this system for other new lines, as well as those where a change is deemed advisable. As this system unquestionably has the endorsement of John D. Crimmins, there is every certainty that it will be a winner.

Aside from this fact, however, the system is one of the best ever tried ; it has few equals if any superior, and might well have been installed on Lenox Avenue, where the Buda-Pesth system is now undergoing test. A description of the Johnson-Lundell system will be given in due time. In general terms, it is one in which the car gets its current from mains buried in a closed conduit through a trolley wheel that runs along a middle rail in the centre line of the track. This middle or current-supplying rail is broken into insulated sections less than the length of a car, and these sections are successively cut into circuit with the mains below as the car approaches them, and cut out of circuit again as the car leaves them in such a way that there is no live rail in the middle of the track except that section immediately beneath the car. The Johnson-Lundell system is not unique in this respect, as there are quite a number of systems that are operated upon this same general plan. It is, however, unique and fairly apart from systems of this sort in the respect that gives it one advantage over others for city work. It is what might be described as a composite system, inasmuch as the car carries a storage battery of sufficient capacity to operate the car for a short distance independently of any connection with the main current underground. This means that the car can go a considerable distance independent of the central station supply. The advantage thus given for making complex street crossings where for a distance the underground supply can be discarded is not inconsiderable. There are means, of course, provided for resupplying the exhausted battery after such a run by connecting it to the power circuit, and thus put the battery in shape for the next independent trip.

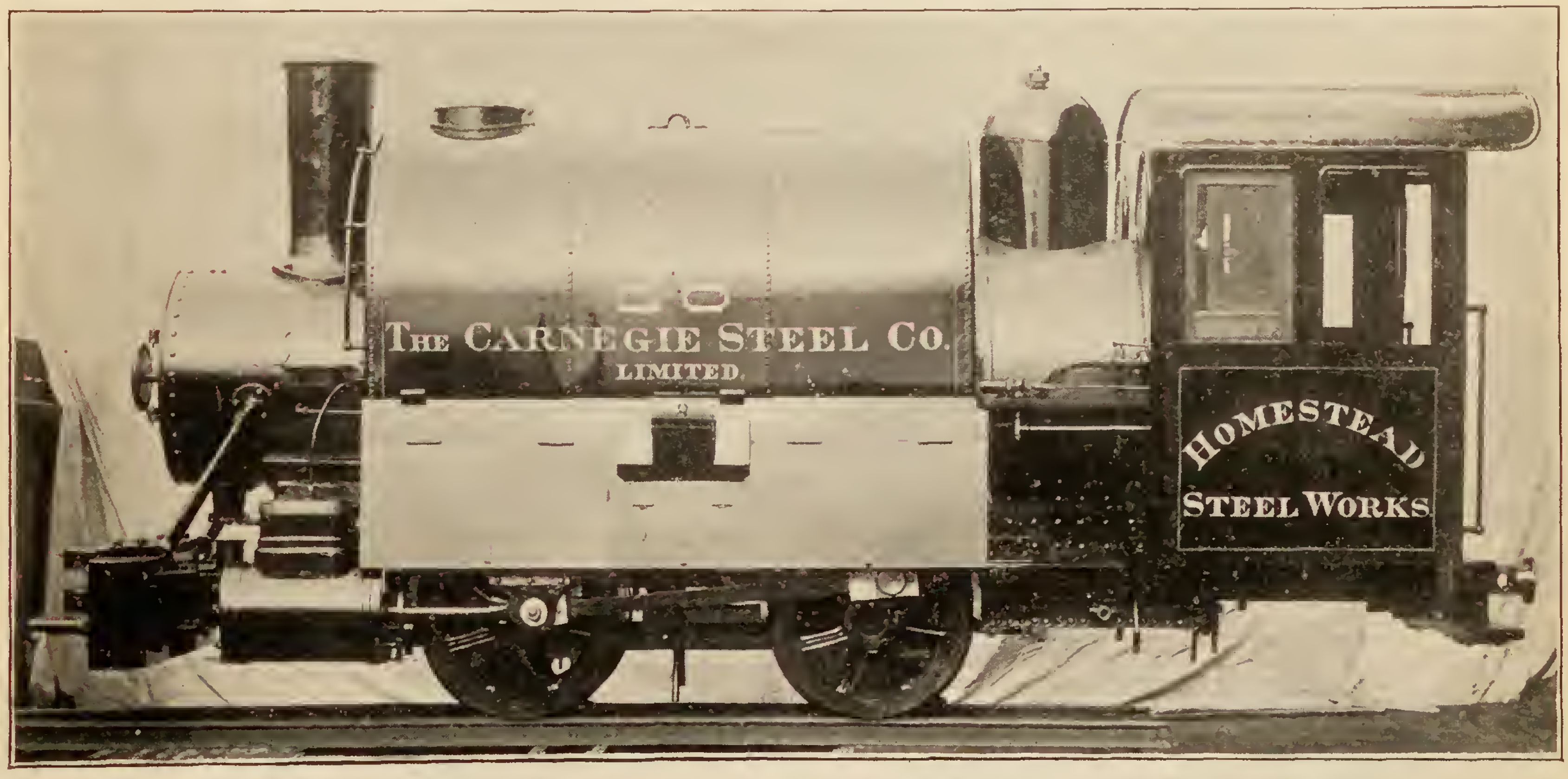
Since our last issue, the Madison Avenue Line, in this city, has been equipped with a trial storage battery car provided with the chloride accumulators of the Philadelphia Storage Battery Company. The first trip was made at night more than a week ago, and the morning papers all had the customary associated press report to the effect that the trial was a complete success in every respect, the car starting off with the expected speed and with as much power as if it were drawn by a locomotive. The car took the sharp curves without slackening speed, while the lights in the car were of unusual brilliancy.

Germany is always surprising us with some novelty in electric application. We now have an electric suspension railroad between Leipsic and Halle. The system is credited to Eugene Langen, of Cologne, and the novelty is described in the meagre reports at hand as the suspension of the cars from an overhead trolley rail (wire). There is nothing new about this, however, as it is one of the oldest plans of electric locomotion devised, and was of British origin. Its serious application to

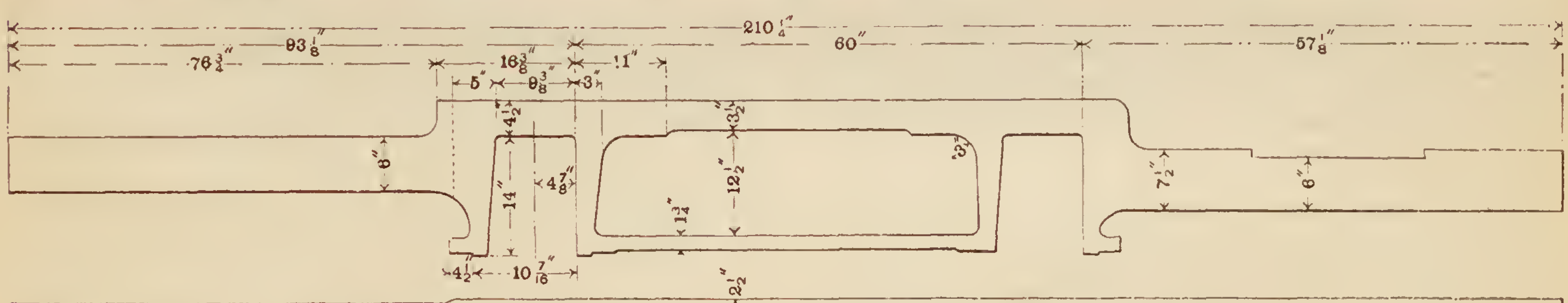
cross-country railroading, however, is novel and rather surprising. The line from Leipsic to Halle is 22 miles long and the distance is covered in 35 minutes, with the promise that it will be reduced to 20 minutes, or at a rate of considerably more than a mile a minute. The report goes on to state that the line is attracting the close attention of the Berlin authorities, with a view to its adoption for an intramural line for that city.

SWITCHING LOCOMOTIVE FOR THE CARNEGIE STEEL COMPANY.

Switching service is undoubtedly the most severe service that the ordinary locomotive is called upon to endure, and in this, as in everything else, there are degrees of severity; but of all the work that a locomotive may be called upon to perform, that of a steel works is perhaps as hard as any. The locomotive is usually slammed about as though it were made of imperishable and unbreakable materials, and the only way in which a satisfactory service can be obtained is to make all of the parts so strong that they simply cannot be broken. The locomotive of which we give illustrations is one that has recently been completed for the Carnegie Steel Works, Limited, by H. K. Porter & Co., of Pittsburgh. The engraving, reproducing the photograph, does not give an adequate idea of the weight and strength of the details of the engine. The following are a few of the principal dimensions :



SWITCHING LOCOMOTIVE BUILT FOR THE CARNEGIE STEEL COMPANY BY H. K. PORTER & CO., OF PITTSBURGH, PA.



FRAME OF SWITCHING LOCOMOTIVE FOR THE CARNEGIE STEEL COMPANY.

Gauge of road	30 in.
Weight of locomotive in working order	41,000 lbs.
Total wheel base	5 ft. 6 in.
Diameter of cylinders	12 in.
Stroke of piston	16 in.
Diameter of drivers	33 in.
Maximum working pressure	140 lbs.
Water capacity of tank	750 galls.
Kind of fuel used	Bituminous coal.
Total length of engine over bumper beams	19 ft. 2 in.
Height top of rail to top of stack	9 ft. 4 in.
" " " " " centre of boiler	4 ft. 9½ in.

When we take these figures and compare them with those given on the detail drawing of the frame, it will be seen that the latter is remarkably heavy. In fact, the forward end is almost if not quite as heavy as the corresponding portion on many standard-gauge locomotives with 16-in. or 17-in. × 24 in. cylinders. The front buffer casting, which is not clearly shown on the engraving, is of steel, and weighs 750 lbs.—an excessive weight, to be sure, but one that was found to be necessary in order to withstand the hard usage to which the locomotive is subjected without breaking. The sides of the engine are well protected by aprons, so as to prevent the dust and ashes that fill the air about the works from settling on the working portions of the machinery. This type of engine presents no novel features in its outward appearance, and its peculiarities lie entirely in the great weight and strength of its parts, which is evidenced from the fact that on a gauge of only 30 in. it weighs more than 2,000 lbs. to the running foot of length.

NOTES AND NEWS.

Plenty of Lumber Still Left.—It is said that Canada has a forest in the Hudson Bay and Labrador region 1,000 by 1,700 miles in extent ; another great forest stretches from Washington State to Alaska. The Amazon basin comprises, perhaps, 2,100 by 1,300 miles of forest. Central Africa has a forest region of 3,000 miles from north to south of an unknown width. Again, the "Taigas" and "Urmans," or vast pine, larch, and cedar forests of Siberia, are 3,000 miles from east to west, and 1,090 miles from north to south. The natives call them "places where the mind is lost."

Life-Saving Service.—In his annual report the General Superintendent of the Life-Saving Service gives the following remarkable data :

"At the close of the last fiscal year the establishment embraced 251 stations, 184 being on the Atlantic, 53 on the lakes, 13 on the Pacific, and one at the Falls of the Ohio, Louisville, Ky. The number of disasters to documented vessels within

the field of the operations of the service during the year was 483. There were on board these vessels 5,402 persons, of whom 5,382 were saved and 20 lost. The estimated value of the vessels involved was $8,001,275, and that of their cargoes $2,645,960, making a total value of property imperilled $10,-647,235. Of this amount, $9,145,085 was saved and $1,502,150 lost. The number of vessels totally lost was 73. In addition, there were 192 casualties to small craft, such as small yachts, sailboats, rowboats, etc., on board of which there were 421 persons, 415 of whom were saved and 6 lost. There were 110 other persons rescued who had fallen from wharves, piers, etc., the most of whom would have perished without the aid of the life-saving crews. The crews also rendered assistance of minor importance to 181 other vessels in distress, besides warning from danger by the signals of the patrolmen 249 vessels. The number of lives and amount of property saved through these warnings is, of course, not known."

The Superintendent pays a high tribute to the heroism of the men in the service, and says that no life was lost through the lack of prompt and faithful effort.

Navigating the Air with Kites.—Lieutenant B. Baden-Powell described a means he suggested for navigating the air by means of kites. He pointed out that as greater height above the surface of the earth is reached, the wind nearly always increases in force. At 1,000 yds. it often blows at three times the velocity that it does near the surface. He proposes to take advantage of this difference by sending one kite to the upper atmosphere, and keeping another nearer the ground. The two kites would be connected by a long line, and the weight to be carried would be attached to the line at a point nearer to the lower kite than to the higher. The lower kite would thus supply a retarding medium to the upper, so that the effect would be the same in principle, though not in degree, as if the upper kite were held to the earth by a string, and the lower kite were towed through the air by a boy running with the string in his hand. By the forces thus brought to bear both kites would be kept flying, although not held to the earth by a string in the usual way, and it is thought that possibly they might be navigated in directions other than that in which the wind might be blowing. It will be seen that the author depends on the difference in velocity of currents of air at two heights; and were this difference to fail, or to become insufficient, the experimenter would come to the ground. This might prove awkward unless a clear field were provided for the descent. The suggestion, however, is ingenious, and no doubt many persons interested in the problem of aerial navigation would be pleased to see the author put his theories to the test of practice.—*Nature.*

MARINE NOTES.

Triple Propellers.—Germany is going to try the triple propeller system on several of her new war ships. The only triple-screw steamer she now has is the *Kaiserin Augusta.*

Penalties and Premiums.—The Navy Department, having abolished speed premiums, has concluded not to overdo the penalties imposed upon ship-builders. Of these last there will be but three, those for delay in completion, deficiency in speed, and overweight of machinery. The proposed penalties for delay in furnishing armor plans and for overweight in hulls will not be enforced.

Chinese Torpedo Cruiser.—The Vulcan Company of Stettin (Stettiner Maschinenbau Actien Gesellschaft "Vulcan"), the largest ship-building firm in Germany, have lately had under construction for the Chinese Government the torpedo cruiser *Feiying*, a ship of 850 tons displacement. During a full-speed trial of four hours duration, which has just taken place, this vessel attained a speed of 22 knots, with engines (made by her builders) developing 4,500 I.H.P., steam for which was obtained from eight Yarrow water-tube boilers having straight tubes, under an air pressure in the stokeholds of only ¾ in. of water.

Report of Chief Constructor Hichborn of the U. S. Navy.—In his annual report the Chief Constructor says that modern steel ships, with their extreme subdivision and elaborate systems of ventilation, drainage, and mechanical auxiliaries of all kinds, require much greater care, both when in commission and in ordinary, than was formerly the case with the old wooden ships; neglect is followed by much more serious and far-reaching deterioration, and it is absolutely essential that the most careful supervision should be exercised at all times and remedies promptly applied in order that the efficiency of the vessels as men-of-war may be properly maintained, and insists that a much larger appropriation is needed this year than last to maintain our ships in a proper state of efficiency. He recommends the construction of only two new vessels to be authorized by the next Congress instead of the great increase to our force of heavy battleships which was unofficially suggested by his paper read before the Naval Architects in New York as being promptly needed by the Navy. The vessels he recommends are two small composite sailing vessels of 1,100 tons displacement, to cost only $250,000 each These, if authorized by Congress, will be the first two vessels without steam power that have been placed in the naval service for many years.

He recommends new docks at Portsmouth, N. H; Boston; Mare Island, Cal., and Norfolk, Va. Until the indefinite time in the future, when the big docks at New York, Puget Sound, and Port Royal are available for deep-draft vessels, the battleships must remain undocked.

Bids for Battleships and Armor.—According to the New York *Sun*, the bids for the new battleships will be opened on the last day of this month, and sharp competition is expected. The armor proposals will also soon be opened. It is observed that the words "Harvey process" are not used in the specifications, but the 7,000 tons of armor called for are to be "in whole or in part, at the discretion of the department, face hardened." It is further said that the hardened plates are to be super-carbonized before forging, and then reduced to the required thickness by forging or rolling at as low a heat as practicable, thus utilizing the results of recent experiments. When finally machined and shaped it will be hardened. The 15 in. side armor will be fired at with a 12-in. gun, and the 17-in. turret plates with a 13-in., which last has never been used in the contract tests even of 18 in. plates. But the increased severity of the tests is warranted by the growing excellence of the plates.

From the same source the following items are quoted:

"Bilge keels, it is said, were omitted from the *Indiana* and other vessels in order to get them into the docks, but the decrease of stability thereby occasioned will probably cause them to be restored.

"An interesting trial, which may soon be expected at Indian Head, is that of the experimental turret representing a similar structure on the battleship *Massachusetts.* It has a double purpose, the primary one being to determine the acceptance or rejection of a group of armor which the plate fired at represents, and secondly the effect of the impact upon the frame. Finally, if the plate is left in condition to be fired at after the contract shots with the 12-in. gun, it will receive a round from the 13 in.

"The report on the test of the Browning automatic gun shows that it gave good results."

Monitor "Monadnock."—An Associated Press report, dated San Francisco, says of this vessel: "Steam was raised in the *Monadnock* on Thursday, October 24, when the vessel was given a dock trial at Mare Island, Cal., to test her machinery. The warship will be entirely completed and ready to be put in commission within a month. All that is lacking now are some minor parts of the gun-mounts, which are on the way from the East.

"The *Monadnock* has been building for 20 years, her keel having been laid in 1874. The old *Monadnock* had done good work during the Rebellion, and in 1866 she was sent to Valparaiso during the Spanish trouble in Chile. When things quieted down in the latter country the monitor was ordered to the Mare Island Navy Yard, and she came here in convoy of the *Vanderbilt.*

"Admiral John Rogers was in command of the convoy, and Admiral Francis M. Bunce, now in charge of the North Atlantic squadron, piloted the *Monadnock* through the Golden Gate. It was in Secretary Robeson's time that Congress began measures looking to the rehabilitation of the Navy. Finding that it was impossible to get appropriations for new ships, Robeson conceived the idea of having the old vessels rebuilt. The expense attached to this came out of the fund for repairs An order was made to rebuild the *Miantonomah*, *Amphytrite*, *Terror*, *Puritan* and *Monadnock.*

"The contract to rebuild the *Monadnock* was let to Secord & Vanderbilt, but the frame-work was done by a firm in Williamsburg. The monitor was put up in frame entirely and then taken apart and the plates shipped to Mare Island in a sailing vessel around the Horn. For years the plates lay exposed to the weather at the foot of Pennsylvania Street, in Vallejo, Cal., where the keel was laid. The ways are still there, and are known as Monadnock Wharf. The appropriations for the "repairs" were very small, and the work was delayed. Several times the plans had to be altered to conform

with the modern requirements, and now it is declared that the *Monadnock* is one of the finest and most efficient warships afloat.

"The *Monadnock* is a double-turreted monitor, and will carry two 4-in. guns in each turret. Her secondary battery will consist of Hotchkiss and Gatling guns. She will carry from 180 to 200 men. The big rifles have been at Mare Island for some months, and are housed over with canvas. The trial trip of the monitor will not be made until the vessel has been ordered into commission. When she goes to sea she will have on board all her men and stores. No officer has as yet been assigned to the command of the *Monadnock*.

"The old *Monadnock* was dismantled at Monadnock ways. Her turrets were removed, and her timbers have been cut up into relics of former glory."

Report of Engineer-in-Chief Melville to the Secretary of the Navy.—In his annual report to the Secretary of the Navy, Commodore George W. Melville points out the necessity for establishing repair stations for war vessels at several of our navy yards, including the Boston yard. He endorses the recommendations of a board for making the League Island yard, near Philadelphia, a naval station second to none in the world. The advantages and surroundings, says the Chief, are too well known to need repetition, and there is every reason why this should be the principal naval station for building, repairing, and laying up modern ships. The Norfolk Yard is well adapted for a building and repair station, and an engine construction plant should be erected in conjunction with the new naval dry dock at Port Royal, S. C. The machine shop at the Newport naval station is too small, and should be augmented. A number of shops to repair machinery and boilers should be erected at once at the Sidney, Wash., naval station. On account of the strategic position of the Key West naval station, Commodore Melville hopes for the establishment there of a suitable engineering plant, which could be used by the commercial marine in an emergency.

In making recommendations as to the use of water-tube boilers, Chief Melville says he appreciates the necessity of proceeding with caution and yet keeping abreast of progressive builders. No single type of water-tube boiler has yet made its appearance which can be regarded as an altogether satisfactory substitute for the Scotch or cylindrical fire-tube pattern, and for this reason the Chief has not recommended their use in the larger and more important vessels, believing it better, for the present at least, to confine them to torpedo-boats, gunboats and the smaller cruisers.

"Conservative as this bureau may be regarded upon this subject," says Commodore Melville, "it has been in advance of every marine engineering establishment in America, for while private firms refused to guarantee a water-tube boiler for naval purposes, the bureau insisted upon their installation as a part of the power in the coast-defence monitor *Monterey*."

It is said by the New York *Sun* that "as a result of the examination by Chief Engineer Perry and Passed Assistant Engineer Bryant of the lake steamer *Zenith City*, a freight boat, water-tube boilers of a pattern similar to hers are likely to be put on the new composite gunboat to be built at Elizabethport, on one of those awarded to the Union Iron Works at San Francisco, and on one of those secured by the Bath Iron Works."

The Chief suggests that one of the gunboats now building at Newport News would be an admirable vessel for testing the merits of liquid fuel. The attention of the department is called to the fact that the number of naval cadets in the engineer division now being graduated at the Naval Academy is not sufficient to supply the vacancies in the Engineer Corps, and he says that if some means for increasing the division can not be found, recourse must be had to the technical schools and colleges.

The Ram "Katahdin."—The Ammen ram *Katahdin*, which was so long in constructing, has recently had her trial. In the contract under which she was built it was provided that unless she would make a speed of not less than 17 knots per hour, maintained successfully for two consecutive hours, during which period the air pressure in the fire-room shall not exceed 2½ in. of water, the vessel to be weighted to a mean draft of 15 ft., she shall be rejected. During the trial she made only 16.13 knots.

Secretary Herbert said that he was powerless to waive the specifications of the contract, which stipulated that unless the ram developed 17 knots or over, the vessel should be rejected. After a long conference with General Hyde, the builder, the Secretary, however, consented to take care of the vessel at the New York Navy Yard pending a further consideration of the matter by President Cleveland.

The keel of the vessel was laid in 1891, and ever since that time frequent modifications have had to be made in the plans because of the discovery of defects. She was delayed two years by the failure of the armor contractors to fill their contract, and in the past year four different sets of propellers have had to be tried on the vessel.

It is claimed by the contractors that, as the model for the hull of the vessel was furnished by the Navy Department, they should not in justice be held responsible for her failure to make the required speed.

The New York *Sun*, from which the above items are taken, says:

"The *Katahdin* has been a long time getting into service. The act authorizing her became a law March 2, 1889, but although the designs of Rear Admiral Ammen were adopted, it was a long time before the plans were in readiness. When the bids were opened on December 20, 1890, it turned out that there was but one proposal for her, at $930,000, made by the Bath Iron Works, and to it the contract was awarded on January 28 following. After the contract was made, changes were suggested and agreed to, which increased the length of the vessel 8 ft., thus giving greater berthing capacity for the crew and space for coal storage; and it was also decided to admit a battery of four 6 pdr. rapid-fire guns, to afford protection against the attack of torpedo boats. Another change was the substitution of a solid steel casting for the stem in place of the ram with removable head originally designed, while the alteration in the shape of the stem secured better manœuvring qualities and greater strength. The height of the conning tower was also increased.

"Much confidence is expressed that the *Katahdin* will be a valuable ship. Her speed trial on Thursday showed her capabilities for her work. She is strongly constructed, and has 72 water-tight compartments between the inner and outer skin. The maximum of her armor is only 6 in., with the exception of the conning tower, which is 18 in., but the curve of her deck aids her defensive strength. Her normal coal supply is 175 tons, and her full bunker capacity about 193, which is ample, as her mission is that of harbor defence."

A New Hydraulic Propelled Steam Lifeboat.—Messrs. Thornycroft & Co., of Chiswick, England, have recently completed a hydraulic propelled lifeboat for the National Lifeboat Institution of Holland, the hull of which was designed by Mr. G. L. Watson, the naval architect of the institution. The *Times* gives the following description of this boat:

"The dimensions of the new vessel, which is built entirely of steel, are: Lengths, over all, 55 ft.; on the water-line, 53 ft.; breadths, moulded, 13 ft. 6 in.; over sponsons, 15 ft.; and extreme, 16 ft., the moulded depth being 5 ft. 6 in. She has an extreme water draft when fully loaded of 3 ft. 3 in.; the load consisting of crew, four tons of coal, mast and sails, some 30 or more passengers, and her tanks full of fresh water, which, with the propelling machinery and boiler, give her a displacement of about 30 tons. The hull of the boat is divided into 18 water-tight compartments, two of which are occupied by the engines and boiler and two forming the coal bunkers, each being capable of being freed of water—the smaller by means of a portable deck pump and the larger by the main engines.

"The propelling machinery consists of a compound surface condensing engine, driving direct a nearly horizontal centrifugal pump, the impeller of which (30 in. in diameter) delivers the water with which the pump is fed, by a scoop-shaped inlet amidships, through four nozzles or outlets in the sides of the boat, two for motion ahead—one on either side—being placed below the water aft, and those for motion astern, close under the sponsons above water, forward. The engine has no reversing gear, but is always running one way, the direction of the boat ahead or astern being controlled by valves in the discharge pipes from the centrifugal pump. These controlling valves can be worked either from the engine-room or by the coxswain at the steering wheel, and by moving one valve only the boat may be made to turn round on her centre, and may consequently be steered independently of the rudder. The boiler for supplying the engines with steam is one of Mr. Thornycroft's patent water-tube type, and is capable of supplying ample steam at a pressure of 145 lbs. per square inch to enable the engines to develop about 250 I H.P.

"The lifeboat is steered by an ordinary deep rudder, which is moved by simple worm gearing and fitted with an arrangement for tricing it up in shoal water, without interfering with steering operations. For working the anchor and warping purposes a steam capstan, driven by an independent engine, is fitted at the after end of the engine-room, a reel of 100 fathoms of flexible steel wire rope being fixed in the cockpit or well of the boat. To assist the propelling power and the steadying of the boat it is fitted with a mast hinged in a tabernacle forward, and when not in use is lowered and stowed along the covering

of the machinery. When in use it carries a lug sail and stay-sail.

"She has been christened the *President Van Heel*. During her trial trips she made a speed of 9.294 knots. After the speed trials the lifeboat was tested in turning evolutions with and without the use of the rudder, and it was especially remarked how easily she was put about or her head put in her desired direction quite independently of that directing instrument. The boat is not only capable of propelling herself, but can at the same time take out with her two or three ordinary lifeboats to the scene of a wreck, her towing power being remarkable, an experiment to test this having been made, when it was found that she had a dead pull—measured by the dynamometer—of 22 cwt., sufficient to enable her to take in tow out of danger a vessel averaging from 200 to 250 tons burden.'

The "Magnificent."—The *Magnificent* is a first-class barbette battleship, which has recently been completed for the British Navy, and has recently had her speed trials, the particulars of which are taken from the London *Times:*

"The *Magnificent* is 390 ft. between perpendiculars, has a beam of 75 ft., and her mean drafts at the time of the trials were 24 ft. 11½ in. for the natural and 24 ft. 8½ in. for the induced draft. Her fully loaded displacement is about 14,900 tons. She was laid down on December 18, 1893, and floated out of the dock she was built in on December 19, 1894, so that within 20½ months she has been built, engined, and so far completed as to have undergone her steam trials, a rate of construction unprecedented in the annals of our royal dockyards and private engineering establishments.

"The propelling machinery of the *Magnificent* is designed to develop 10,000 I.H.P. under natural draft and 12,000 I H.P. under forced draft. It consists of two complete sets of triple-expansion engines in separate engine-rooms, each having three inverted cylinders of 40 in., 59 in. and 88 in. diameter respectively, with a piston stroke of 51 in. Each set of engines drives a four-bladed gun-metal screw propeller 17 ft. in diameter and 19 ft. 9 in. pitch., the crank and propeller shafts being of forged steel. Steam is supplied to the engines by eight single-ended boilers of the ordinary cylindrical marine type, with four furnaces in each, and are made for a working pressure of 155 lbs. per square inch. They are designed to supply sufficient steam for the engines to develop 10,000 I.H.P. under natural draft and 12,000 I.H.P. with induced draft. The ship has coal bunker capacity provided for 1,850 tons, equal to a coal endurance for 28 days at a 10 knot speed, the coal carried at her load draft being about 900 tons.

"The higher efficiency of her boilers is attained by fitting large air suction fans in their uptakes, which are run at a speed that will cause a less pressure in them than with mere natural draft; and thus to suck or draw, by difference of pressure, the ordinary air of the stokeholds through the fuel in the furnaces instead of forcing through what is practically compressed air, as when the closed stokehold system is adopted. To create this induced draft the *Magnificent's* boilers are fitted with eight air fans, each 8 ft. 6 in. in diameter, driven by independent engines, which can be worked together or separately, as may be required, provision being made for returning to natural draft at any moment.

"The temperature of the stokeholds during the induced draft trials was never high. This was due to the fact that they are always open to the external air, while in the case of forced draft they are shut off entirely from it. An important point in the application of induced draft to boilers is the keeping of the temperature of fan chambers and casings as low as possible. This is provided for by the application of asbestos linings and ample air passages around them."

Under natural draft and a pressure in the boilers of 150.5 lbs. per square inch the engines developed 10,301 total I.H.P., and the speed of the ship was 16.5 knots per hour; under induced draft the engines, with 154 lbs. pressure, developed 12,157 H.P., and the speed was 17.6 knots. The *Times* says, further:

"As opinions are divided as to the advantages of induced over forced draft applied to marine boilers, the trials of the *Magnificent* have been looked forward to with special interest. They are so far conclusive as to prove that an increased pressure of steam may be more quickly raised and maintained. There is also a decided gain so far as the health, comfort, and safety of all who are engaged in the boiler stokeholds are concerned."

The Battleship "Texas" Injured in Docking.—The daily papers have recently contained long and somewhat sensational accounts of injury to the *Texas* when she was placed in the dry dock in Brooklyn in the early part of November.

The *Texas* was authorized by Congress in August, 1886, to be built from designs which were furnished by William John or Johns, of the Barrow Ship-Building Works, in England, who designed the *City of Rome*, etc. His plans, it is said by a writer in a New York paper, although endorsed by Commodore F. E. Chadwick and Lieutenant B. H. Buckingham, naval attaches of the United States Legation at London and Paris respectively, were soon afterward utterly discredited by another English expert—Mr. Bryce-Douglas—who had succeeded Mr. Johns in the Barrow Company. This expert, who was paid an additional $7,500 for engine designs for the *Texas*, informed Secretary Whitney that under the Johns plans the *Texas* would not be able to carry the weights and required displacements, and advised an addition of 10 ft. to her hull, giving 370 more tons of displacement, or a total of 6,670.

Secretary Whitney favored proceeding on the old plans, and Chief Naval Constructor Wilson declared that such a course would prove disastrous. Whitney had his way, and was supported by Assistant Naval Constructor Bolles.

The Secretary of the Navy was very much criticised at the time for going to England for plans of a ship.

She was built by the Government at the Norfolk Navy Yard, and was launched in June, 1892.

The displacement of the battleship is 6,300 tons; length, 290 ft.; beam, 64 ft.; draft, 22½ ft. She is protected along each side by a nickel steel belt 116 ft. long and 12 in. thick. Her battery consists of two 12-in. guns, six 6-in. guns, four 6-pdrs., four 3-pdrs., and six torpedo-tubes. Her cost was about $3,000,000. A writer in the *Sun* says: "There has been much criticism, too, on the construction of the vessel. In the opinion of many she is structurally weak."

Among the other developments during construction which increased the impression that her hull was not strong, was the accident to her boilers when they were first filled, the weight of the water breaking the saddles which supported the boilers. A bed plate of her auxiliary engines broke during the dock trial at Norfolk, the accident being caused, it was asserted, by the excessive flexibility of the hull.

The *Texas*, when completed, turned out to be the only vessel of the new navy that had not exceeded her designed draft. This, it is contended by naval officers, is due to the fact that much of her iron work was intentionally made lighter in weight as well as in strength, the sacrifice having been made in order that she might float higher, and in order to secure her completion, as far as possible, within the price fixed by Congress.

An official investigation and report of her injuries has been made by Naval Constructor Bowles, who reports that the ship was carefully docked and every usual precaution observed. "The bending of the brackets and floor plates," he says, "was due to the bending up of the ends of the cab blocks. The structural strength of the ship was not affected."

As the *Columbia* was also injured in docking recently, we have reprinted elsewhere for the benefit of our naval brethren some suggestions communicated by a correspondent of an English paper describing what he says is a safe system of preparing for and docking men-of-war. The editor of the paper says:

"It is a matter of common knowledge among those in charge of graving docks, that a war vessel, on account of its heavy weight, requires much more careful management and much more support than an empty merchant vessel. In view of this fact, the following communication from a correspondent who has had considerable experience in such work may be of interest:

THE DOCKING OF WARSHIPS.

"'Having noticed in the Liverpool *Journal of Commerce* of August 15, 1895, that the United States cruiser *Columbia*, while being docked at Southampton, received slight and local straining forward through supposed insufficient support and wrong placing of shores, it may be of interest to your readers to receive a good and safe system of preparing for and docking men-of-war.

"'Previous to the vessel being docked, and before the water is let in, the surface of the docking blocks should be examined and tested to have the same declivity as the vessel's water-line in reference to the keel-line.

"'This is easily performed by having a declivity batten about 20 ft. long, with its upper edge horizontal, while its lower ditto rests on the surface of the blocks, testing it along the whole range of the blocks. The key blocks are generally of iron, and those in contact with it iron cased, when if the remaining blocks are of wood it will be necessary to lash them to eyebolts in the bottom of the dock to prevent their being misplaced by the inrush of and buoyancy of the water.

"'The position intended for the bow and stern of the vessel are marked on the upper side of the dock; distance lines are

prepared, marked by knots at equal distances on each side of the centre weight. These are tested for accuracy, to prevent the unequal stretching of the cord. If possible the shores are prepared by fixing temporary sections at intervals on the corresponding parts of the blocks—say four or six sections, one being at amidships—and the length taken.

" 'The shores should be fitted as near as possible square to the curvature of the ship at the parts selected, and, if possible, in a line with the several decks, bulhkeads, and at the junction of intercostal and transverse framing.

" 'Their number should be increased in the region of extra weight, such as turrets, barbettes, machinery, and the overhanging extremities—*i.e.*, stem and stern should receive extra attention.

" 'The heads of the shores should be pointed above a level to avoid the strain on them having a tendency to prevent the vessel from lifting after the water is admitted for undocking purposes.

" 'The vessel having been brought to the dock entrance with the bows facing up the dock, bow ropes are passed along the dock sides round steam capstans, and by this means she is hauled into dock; at the same time, if there should be any set of the tide outside the dock, the stern is kept in its proper position by steam tugs. She is thus brought to her allotted position over the blocks, when the gates are replaced and the water pumped out. She is next tried to be over the centre line of the blocks by means of the distance lines at the bow and stern, and all list prevented by proper disposition of weights on board, and checked by a plumb line down the hatchways; also by outwinding a vertical batten placed at the head of the dock—in the line with centre of blocks—with similar uprights on board or by the line of the masts. When she has settled on the blocks the breast shores are set taut; then the other tiers of shores in succession, simultaneously on both sides of the ship. By this means each part of the vessel is properly supported, and the blocks bear their due proportion of the weight.

" 'Often in position of great local weight, the double bottom space is shored, and diagonal shores fitted to the decks to prevent any possible deflection at these parts.

" 'The great principles in docking men-of-war are:

" '1. To have the blocks fitted to the same declivity as the draft of the ship, so that her keel may touch along its whole length simultaneously.

" '2. To keep the ship on the true centre line of the blocks, and avoid all appearance of list.

" '3. To concentrate the shores in the positions of greatest weight, and at the place of greatest strength—*i.e.*, line of decks at side, bulkheads, and at the intersection of longitudinals, with transverse framing. If this is carefully attended to, no possible straining or deflection would ensue.

" 'THOMAS H. SCURLOCK,
" '*First Medallist Naval Architecture.*' "

SHOP NOTES.

NEW YORK, SUSQUEHANNA & WESTERN RAILROAD, NORTH PATERSON SHOPS.

MR. ENNIS is much pleased with his new Rogers 19 in. × 24-in. mogul freight engines. They have 54-in. wheels on a rigid base of 14 ft. 6 in., and 22 ft. 2 in. total. Weight on drivers, 110,000 lbs. and 17,000 lbs. on truck wheel. His heavy passenger engines have 18-in. × 24-in. cylinders, 62 in. wheels, 8 ft. rigid and 22 ft. 4 in. total wheel base. Weight on drivers, 67,800 lbs., and 103,000 lbs. total.

Repair bills on these engines are very light. He removes his tires by means of a portable gas apparatus.

Water for supply of shops at North Paterson comes from a deep well, and produces a very white, light, porous scale. This is kept from accumulating by occasional application through the injector of ordinary refined petroleum. The scale closely resembles the scale produced by the artesian water of Savannah, Ga.

He uses asbestos covering to his boilers, and fails to find any corrosion of the surface of the boiler plates even after a service of many years.

Has some Smith exhaust pipes, which do very well. In one case it enabled him to retain in service a switching engine of which the exhaust had been complained of as making much noise by the residents of the neighborhood. By changing the pipes all complaint ceased, and no other change to the engine was required.

DELAWARE, LACKAWANNA & WESTERN RAILROAD, KINGSLAND SHOPS.

Mr. Lewis takes care of 169 engines at this shop, where there are only nine pits in the erecting shop. He is in hopes that in the near future an additional shop will be built between the present transfer table tracks and the roundhouse, which will relieve the present crowded floor space and give him an opportunity to put in some wood-working machines, of which he has none. In addition to the locomotives, he has two tug boats and several barges, with their hoisting machinery, to keep in order, the switch work of the road department, and the Pintsch gas plant maintenance and repair. To furnish compressed air for the numerous hoists in the shop, as well as the two pneumatic hammers, he has a Pedrick & Ayer compressor, operated by belt, and giving very good results. By automatic regulator the belt is thrown off and on as the required pressure is obtained or lost. Has stopped trouble from leaking lower joints of steam pipes by using four instead of two bolts through lower flange. Is applying Gould couplers to front end of all engines and back ends of all tenders. Uses both single and double nozzles, placing the top of the former 23 in. and the latter 21 in. below the top of smoke arch. Uses Krupp tires almost exclusively, and when new they are 3½ in. and 4 in. in thickness. Has 40 or 50 engines equipped with the Rushford feed-water heater, which gives no trouble and saves fuel. A Niles turret-headed lathe is very highly spoken of; will take 2 in. round iron. Sellers' spiral motion planer with very quick return motion is also very highly commended.

CENTRAL RAILROAD OF NEW JERSEY.

The new model of the Smillie coupler with face knuckle and square shank is being applied to the 500 new coal cars of 60,000 lbs. capacity which this company are now getting.

PROCEEDINGS OF SOCIETIES.

The New England Railroad Club.—The evening for holding the regular meetings of this Club has been changed from the second Wednesday to the second Tuesday of each month. The meetings are held in the evenings at eight o'clock.

Civil Engineers' Society of St. Paul.—At the meeting of November 14 Mr. Hilgard illustrated the method of hydraulic grading in vogue on the Northern Pacific Railroad system. Under favorable circumstances the work of replacing worn-out wooden trestles with embankments is done at a cost of five cents per cubic yard.

The National Association of Manufacturers.—The time for holding the annual convention of this association has been postponed to Tuesday, January 21, 1896, and will be held at Chicago. The reasons given for the postponement are that the experience in organizing a constituency for the convention has developed a work of greater magnitude than was originally anticipated, and that the period in which the work of organization was undertaken has been largely taken up in political matters.

Liverpool Engineering Society.—At the meeting of October 30 Mr. Arthur J. Maginnis, the President, gave some interesting figures regarding the actual performances of cargo steamers at sea. He said that the following results have, at the various periods stated, been obtained from the consumption of 1 lb. of coal:

In 1840	1 lb.	coal	propelled	.578	displacement tons	8	knots	with	.057	tons	earning weight
" 1850	"	"	"	.6	"	9	"	"	.16	"	"
" 1860	"	"	"	.82	"	10	"	"	.27	"	"
" 1870	"	"	"	1.8	"	10	"	"	.9	"	"
" 1880	"	"	"	2 1	"	10	"	"	1.05	"	"
" 1890	"	"	"	3.23	"	10	"	"	1.93	"	"
" 1895	"	"	"	3 4	"	8	"	"	2	"	"

Convention of the American Society of Mechanical Engineers.—The order of proceedings of this meeting, which will be held in the society's house at No. 12 West Thirty-first Street, New York, December 3-6, has been issued by the Secretary. At the first day's session the following topical questions will be discussed:

For filtering oil having very finely divided metallic particles in suspension, what have you found to be the best filtering material, either for one operation or in a series?

What information can you give as to the best method for the extraction of oil from condensed steam, where it is desirable to use the exhaust steam repeatedly for boiler feed purposes?

What is the economy, if any, of damper regulation in firing with liquid or gaseous fuel?

In boilers fired with liquid or gaseous fuel, is there any advantage in simultaneous regulation of the fuel supply and the position of the damper, either by the same or by different mechanisms, under the ordinary control of the steam pressure?

Are there any conditions under which oil fuel is cheaper than coal for generating steam at points in the Atlantic seaboard States; if so, what are they, and where?

Is an air chamber of any value on a duplex boiler feed pump of 4 in. to 6 in. stroke?

Has any member had experience in planning a successful working system of classification which is better than the Dewey system for books in an engineering library?

In a centrifugal pump at constant speed, how is the efficiency effected (*a*) by throttling the delivery; (*b*) by a by-pass?

In a centrifugal pump receiving water under a head, does the whole amount of the head add to its normal lift?

What is the common method and best practice for determining the largest sizes of pipe desirable to use in mill heating, both by live and exhaust steam.

In the operation of annealing tool steel, what is the essential or principal condition to be observed to insure the best success?

What rule is there for determining approximately the H.P. required to drive disk fans for exhausting and ventilating?

Has any one found it to pay to exhibit in recent international expositions, where to do so entails a cost of attendance, transportation and other heavy charges?

Is there any reliable method for calculating the cost of one machine, if the cost of a larger number is known; or, conversely, if you know the cost of one machine, can the cost of building a larger number of the same machine be satisfactorily calculated?

Has any term ever been suggested to discriminate between the elastic resistance offered by a body to a force tending to change its shape and that offered by the same body to a force tending to change its volume? How much of the latter kind of elasticity has india-rubber?

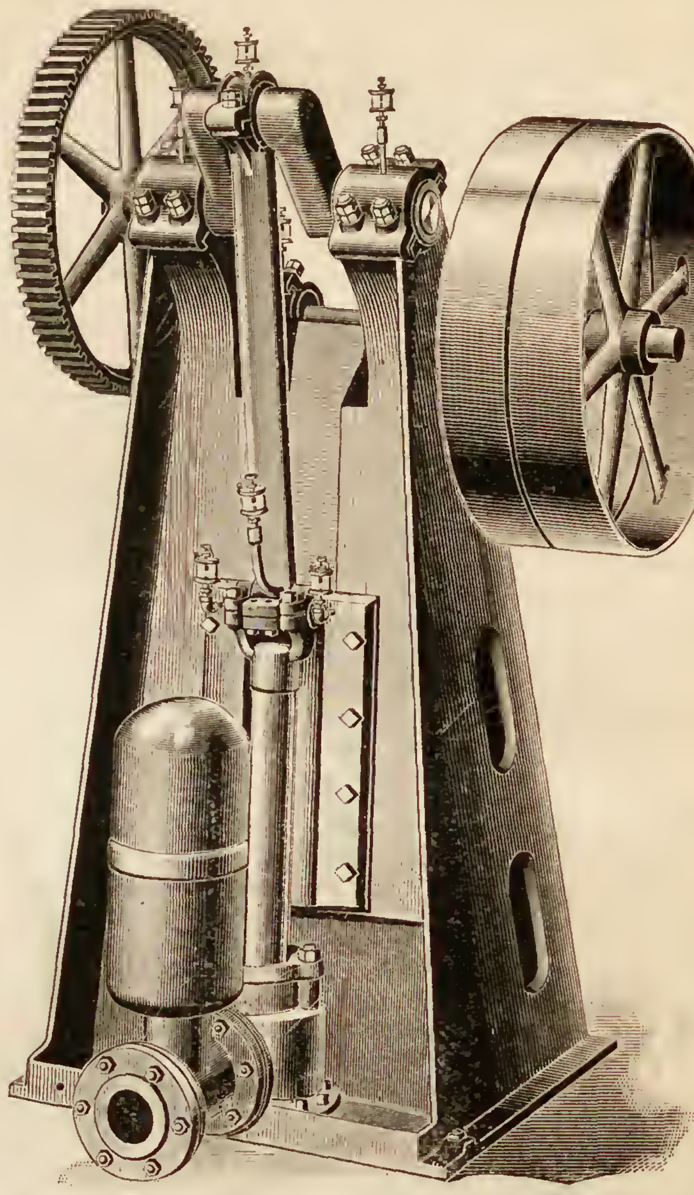
On succeeding days the following papers will be presented and discussed: Water Power of Caratunk Falls, Kennebec River, Me., by Samuel McElroy; Water Power, its Generation and Transmission, by Samuel Webber; Means adopted for Saving Oil in a Large Oil Refinery, by C. E. Emery; The Reliability of Throttling Calorimeters, by James E. Denton; Some Experiments with the Throttling Calorimeter, by A. A. Goubert and E. H. Peabody; Comparative Tests of Steam Boilers with different Kinds of Coal, by C. E. Emery; Experiments on the Friction of Screws, by Albert Kingsbury; Tests of a 10-H.P. De Laval Steam Turbine, by W. F. M. Goss; Recording Device for Testing Machines, by George W. Bissell; Effect of Temperature on the Strength of Wrought Iron and Steel, by R. C. Carpenter; Some Data relating to Forge Shop Design, by P. M. Chamberlain; Experimental Method of Determining the Effective Centre of the Light Emitted from a Standard Photometric Burner, by D. S. Jacobus; The Proportions of High-Speed Engines, by John H. Barr.

A reception and conversazione will be held for members and their ladies at Delmonico's, Twenty-sixth Street and Fifth Avenue, on Thursday evening at 9 P.M.

DIFFERENTIAL POWER WORKING HEAD FOR DEEP-WELL PUMPS.

THE Baldwinsville Centrifugal Pump Works, of Syracuse, N. Y., are manufacturing a very compact and powerful head for working deep-well pumps. As they are situated at the centre of the salt industry of New York State, this head is a natural development due to the requirements of the salt manufacturers. It is driven by a belt running on a tight and loose pulley that are on the lower shaft which runs back of the head and carries a pinion meshing in with the gear shown at the left. It is fitted with crosshead and adjustable guides, and is fitted with cut gears, steel crank, and is a strong, neat, and compact outfit intended for heavy and constant work. It is so arranged that by disconnecting the cross-head the connecting-rod can be thrown back out of the way, and by disconnecting the discharge casting the plunger or piston of the working barrel can be withdrawn without moving the working head from its foundation.

The special points of excellence of this machine are that the main frame is a solid casting instead of being built up; that it is provided with cross-head and adjustable guides; that the differential plunger is sufficiently large to be easily packed and kept packed, and the fact that this cross-head runs in guides prevents any side motion, and thus the stuffing-box is always tight. These points, together with the fact that the working part of the pump can be withdrawn without removing the



DIFFERENTIAL POWER WORKING HEAD FOR DEEP-WELL PUMPS.

pump from its base or disconnecting the suction-pipe, makes it a very complete outfit. These heads are furnished in sizes varying from 12 in. to 24 in. stroke.

Recent Patents.

PAGĀN'S PROPELLER.

THE object aimed at by the inventor of this improvement is to so construct a screw propeller that it will draw the full supply of water necessary for its area of blade surface only from the direction in which the vessel is advancing. "This object," he says, "I attain by making a hollow hub, so as to destroy the vacuum that is found in propellers now in general use." From the side view (fig. 2) it will be seen that a plate or boss, B', is attached to the propeller shaft D. Another plate, B^2, which has an opening, b', in its centre is placed some distance from B' and the lugs or bosses on the inner ends of the propeller blades A A are fastened between these two plates by bolts C C. The blades are prevented from turning by lugs b b on the plates which enter corresponding cavities in the propeller blades. This leaves a hollow opening at B, into which the water can flow through the spaces b^2 b^2 between the bosses of the propeller blades, and can escape through the opening b'. The inventor is O. Pagān, of Philadelphia. The patent is dated October 29, 1895, and the number is 548,655.

PIERPOINT'S WATER-TUBE BOILER.

From fig. 3 it will be seen that this consists of an upper steam and water-drum, 2, a lower mud-drum, 3, a bank of tubes, 4, connecting these drums, and a partition wall, 5, located between the tubes of the bank and arranged to cause an up-and-down pass of the furnace gases over the tubes, and by keeping certain of the tubes in a cooler place insure a strong circulation and efficient abstraction of heat.

6 is the furnace, from whence the gases pass upwardly among the front rows of the bank, then descend among the

rear rows, and thence ascend through the outlet flue 7. Deflecting plates 8 are employed to hold the gases in contact with the tubes, thus insuring the abstraction of heat thereby.

In the steam and water-drum I provide a vertical longitudinal baffle-plate, 9, which is preferably bolted to the inside of the shell by angle irons 10 at the ends and extends upwardly to a point above the water-level. This plate extends between

FIG. 1.

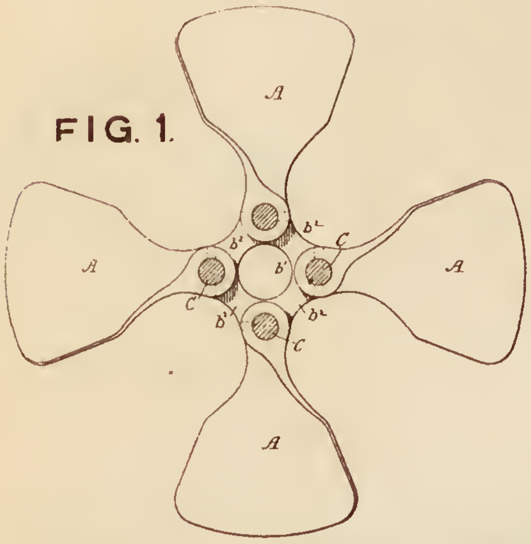
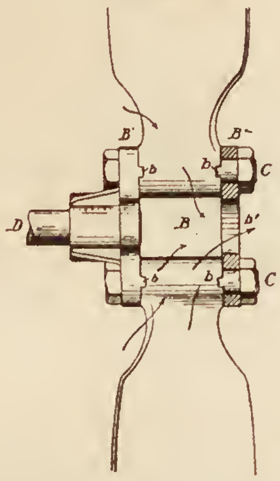


FIG. 2.



PAGAN'S PROPELLER.

the tube ends, and the feed-water entering through the pipe 11 on the left-hand side of the plate is prevented thereby from mingling with the hotter water rising through the tubes nearer the furnace, but descends through the rear rows in a less violent manner than in the main circuit, from which it is cut off by the baffle plate, thereby giving a much better deposition of sediment.

The inventor, Mr. James Pierpoint, of Pittsburgh, says :

" The heat of the gases is fully extracted on account of the lower temperature of the rear tubes down which the feed-water passes, while a violent circulation takes place between the front rows and these rear rows, which are not cut off by the baffle-plate."

The patent is dated October 22, and numbered 548,455.

NORMAND & SIGANDY'S WATER-TUBE BOILER.

Messrs. Jacques Augustine Normand and Pierre Sigandy, of Havre, France, have patented in this country the improvement in the celebrated Normand boiler shown by figs. 4 and 5, which consists in connecting two such boilers together and working them in couples. Fig. 4 shows a sectional view of one such boiler and part of another, the upper or steam-drums C C' of which are coupled together by the connections M and N, and the lower or water-drums B B' are united together at O P. Fig. 5 is a transverse section of one of these boilers of the usual form.

In explaining their invention, the patentees say :

" The lightness of multitubular steam generators in which water circulates through the tubes is chiefly due to the small volume of water which the said generators contain. In multitubular steam generators so constructed, however—in particular in the marine type—variations in pressure are very considerable ; so that, when several generators are coupled together

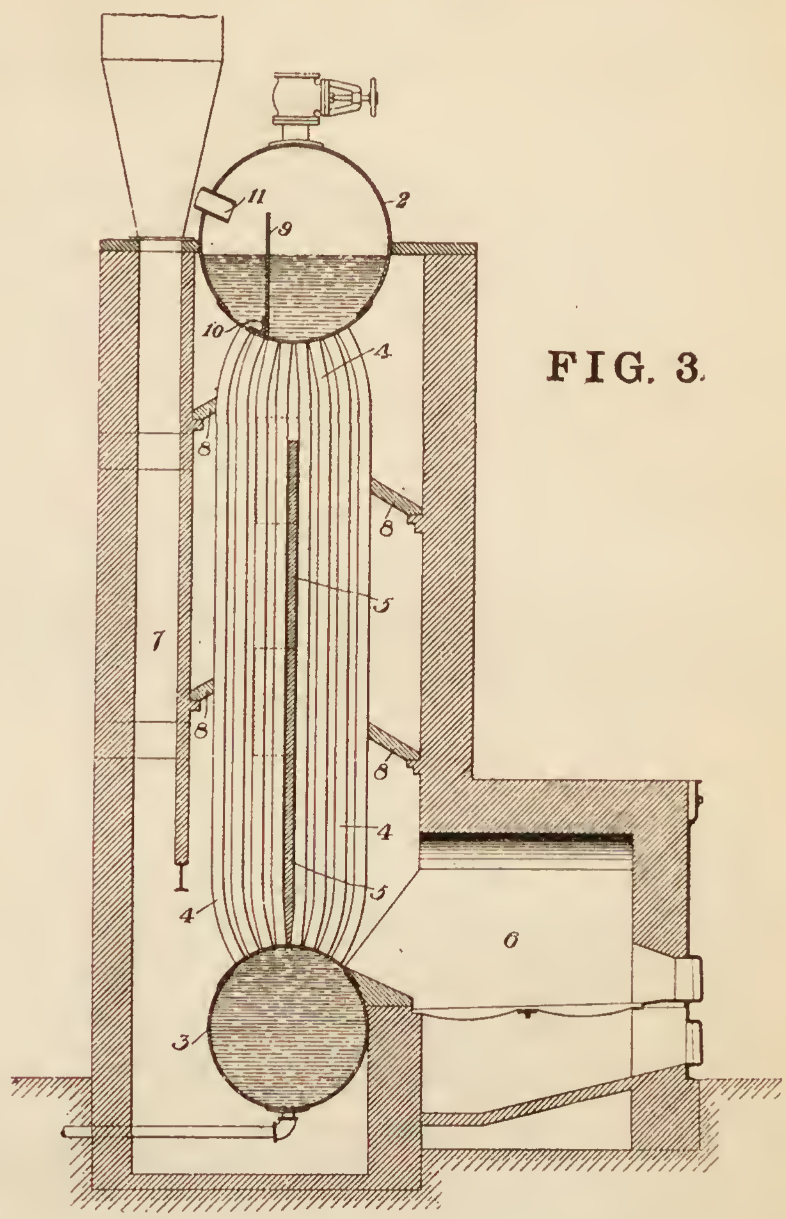


FIG. 3.

PIERPOINT'S WATER-TUBE BOILER.

for supplying steam to one engine the regular distribution of the feed-water to the different boilers gives place to serious difficulties, since the water has a tendency to enter the boilers where the pressure is lowest and where the discharge is consequently the smallest. It would, therefore, seem useful to diminish as much as possible the number of generators thus coupled together, since the work and supervision which a regular distribution demands would be diminished in like proportion. There are, moreover, advantages gained by the use of

FIG. 4.

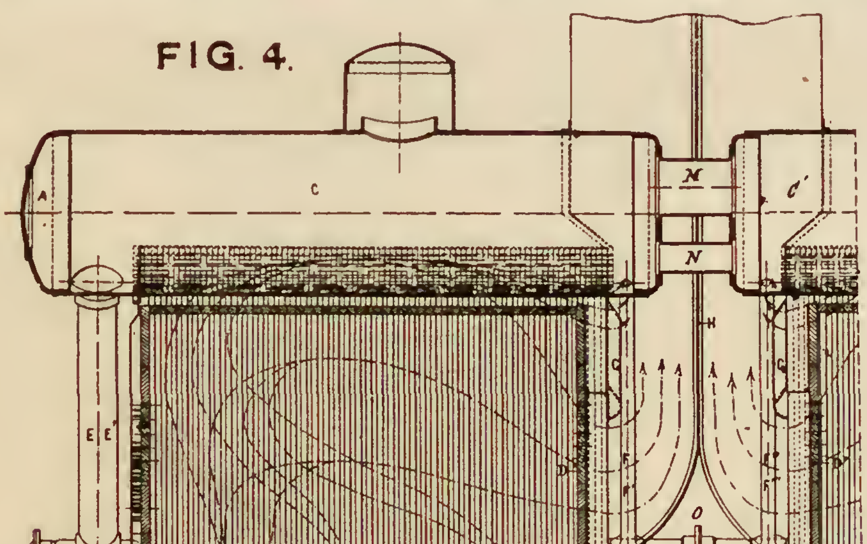
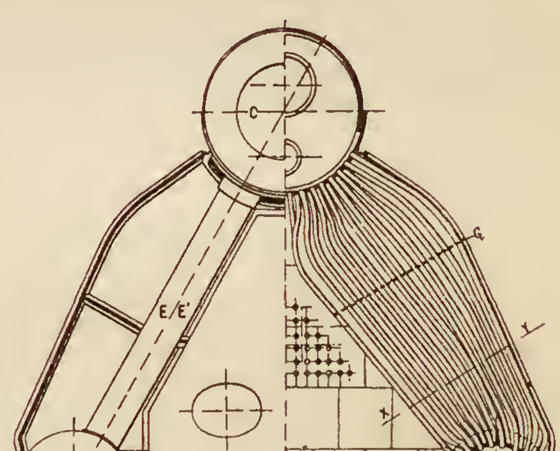


FIG. 5



NORMAND & SIGANDY'S WATER-TUBE BOILER.

coupled generators, more especially in respect of the pipes, the cocks and valves, the reduction of temperature of the compartments, and the spaces occupied by the generators, which, in the case where several generators are in use, outweigh the disadvantages, such as that two generators instead of one become unavailable in the case of damage, and that there is a greater variation of the level of the water at the ends of the upper reservoir, which is caused in the case of marine boilers by the motion of the sea and the variations in the trim of the boat."

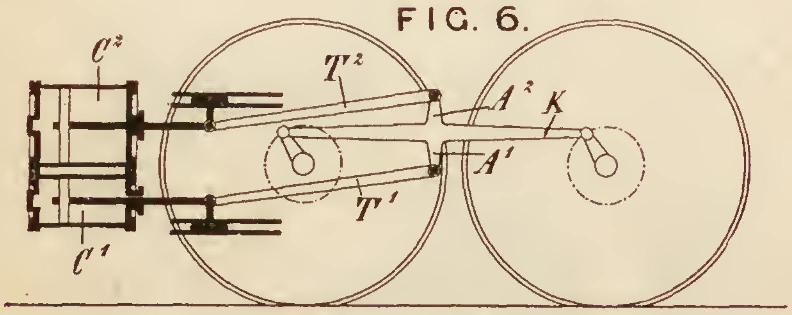
Their claim is: "In a multitubular steam generator, the combination with two generators of like character provided with distinct furnaces and united to form a single combined generator, of an upper central receiver constructed in two like parts arranged end to end, and a contracted neck or necks joining said receivers whereby communication between the same is established, substantially as and for the purpose described."

The patent is dated October 22, 1895, and is numbered 548,451.

SONDERMAN'S LOCOMOTIVE.

In order to remove the disadvantages in the well-known arrangement of superposed high and low pressure cylinders such as have been used in locomotive and other engines, Mr. Conrad Sonderman, of Stuttgart, Germany, has devised the arrangement shown in fig. 6. These defects, or disadvantages, he says, "consist in pending moments on the cross-head and piston-rods which frequently result in a fracture of these parts."

FIG. 6.



SONDERMAN'S LOCOMOTIVE.

To overcome this difficulty he makes the coupling-rod K (fig. 6) of his locomotive with projections, A^2 and A', and each of his cylinders has a separate connecting-rod which is coupled to the projection referred to, as is shown in the engraving. By this means, he says, the pressures on the two pistons are transmitted to the two crank pins simultaneously in an advantageous manner, the connecting-rods T^2 and T'', the coupling-rod K and its bearings are all arranged in one vertical plane.

He says, further, that the cross-heads may be arranged above and below the piston-rods, as shown, or between them or a single cross-head, for the two cylinders may be used. Other methods of applying the same principle are also described.

The patent is dated October 25, and is numbered 547,899.

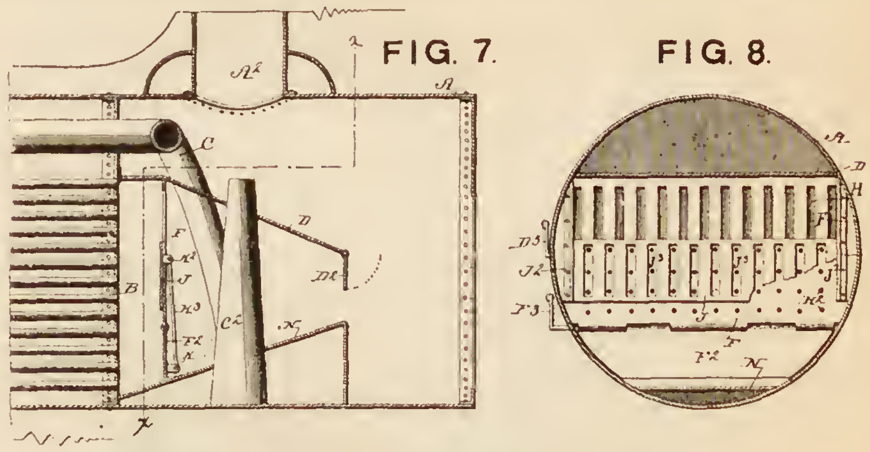
BRITTON'S LOCOMOTIVE BOILER DIAPHRAGM.

The amount of ingenuity which has been and can be exercised in devising appliances for regulating and controlling the draft of locomotives seems to be boundless. Figs. 7 and 8 show an invention of Mr. William Britton, of Boone, Ia., which, he says, will "accurately control the drafts through the boiler tubes and prevent the accumulation of ashes immediately in front of the lower tubes."

D and N are converging deflector plates which extend from the tube-plate forward toward the front end of the smoke-box. D^2 is a damper hinged at its upper edge and adapted to be operated by the engineer. F is a vertical diaphragm having elongated perforations H in its upper portion and circular holes H^2, as shown in fig. 8. This diaphragm, as will be seen, is placed a short distance in front of the front tubes. J indicates a plate which, it is said, is "slidingly mounted on the rear face of F, and is provided with vertical slots J^3" which alternate with those in F. F^2 is another damper hinged at its upper edge Means are provided for operating this damper and the plate J synchronously so as to close the upper slots in the diaphragm when the damper F^2 is opened. A portion of the draft is permitted to pass through the central perforations in the diaphragm at all times, and the fire in combustion chamber of the locomotive may be made to burn better toward the front of the chamber by closing the damper and lowering the slide J, thus permitting the greater part of the products of combustion to pass through the upper boiler flues, and if it is desired to make the fire burn better in the rear of the combustion-chamber the dampers are arranged so that the greater part of the products of combustion will pass through the lower flues, and this may be accomplished by the movement of a single lever.

By the arrangement of the deflector D, the damper D^2 and the inclined plate N the draft through all of the boiler flues may be regulated and the ashes prevented from stopping up

FIG. 7. FIG. 8.



BRITTON'S LOCOMOTIVE BOILER DIAPHRAGM.

the lower flues, and by the construction and arrangement of the diaphragm and the damper and slide the relative amount of draft passing through any section of boiler flue may be readily and quickly controlled.

The date of the patent is November 5, and its number 549,225.

CLIFF'S FREIGHT-CAR TRUCK.

The introduction of the Fox pressed-steel truck seems to have stimulated the inventive faculties of car-builders in devising some substitute for it. Figs. 9 and 10 represent a form of truck recently patented by Mr. Edward Cliff, of Newark, N. J. The frame of this is to be made preferably of iron or steel, forged or cast, and is made of an I sectional form, as shown at b'' of fig. 10. The frame, as will be seen, is made with an open-mouthed jaw at each end to admit the journal-box. Each jaw is closed by a removable bar, H', which is fastened by bolts J and K at its upper and lower ends. The jaws are made deep enough to receive a coiled or other spring, H, above the box. This has a central bolt, i, which passes through the truck frame. By screwing up the nut on this bolt the tension of the spring is taken off of the box, and by removing one of the bolts J or K the bar H' can be swung

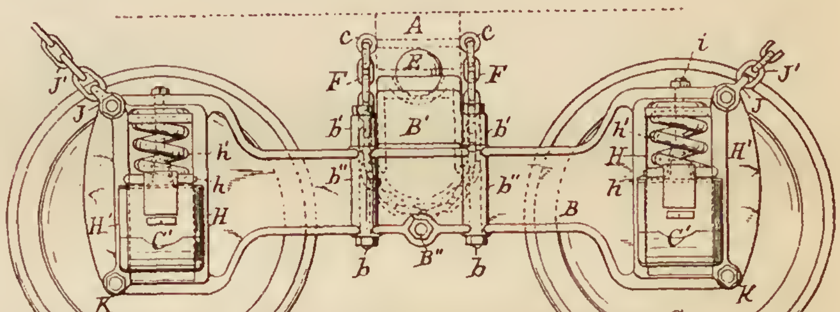


FIG. 9.

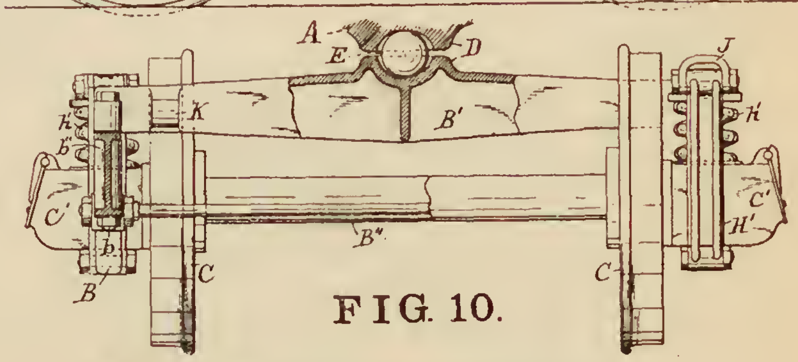


FIG. 10.

CLIFF'S FREIGHT-CAR TRUCK.

open and the box removed. The truck bolster B' is made of an inverted ∩ shape and rests on top of the side frames and is bolted to them by suitable lugs, b' b' and b'' b'', and with the bolts b b. Instead of having a centre pin, the upper and lower centre plates are made with suitable cup-shaped cavities and are provided with a metal ball on which the car body rests and can roll. The cavities being made somewhat larger than the ball, the body and the truck can move slightly in relation to each other. The patent is dated October 29, and is numbered 548,827.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

The American Railroad Journal, founded in 1832, was consolidated with Van Nostrand's Engineering Magazine, 1887, forming the Railroad and Engineering Journal, the name of which was changed to the American Engineer and Railroad Journal, January, 1893.

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NEW YORK, DECEMBER 12, 1895.

EDITORIAL NOTES.

On January 1 The American Engineer and Railroad Journal and the *National Car and Locomotive Builder* will be consolidated into one publication, with the title American Engineer, Car-Builder, and Railroad Journal. The form of the paper will then be changed, and it will be issued monthly thereafter, and the subscription price will be reduced to $2 per year. Mr. M. N. Forney will have charge of the editorial department, with competent assistance.

In another column we publish a description of a mammoth locomotive running-shed that has been built in England for the accommodation of 180 locomotives. We know of nothing comparable to it in point of capacity, and it is certainly a strong argument in favor of the running-shed over the roundhouse that so large a number of locomotives can be accommodated in so small a space. If there were no arguments against this method of housing, however, there would be no reason why all American roads should not immediately fall into line and adopt that type of construction. The American and English locomotive superintendents cling each to the national type, and it will probably be some time before either will be adopted in the territory of the other. The American and the compartment type of car have been contending for the supremacy for many years, with indications at present pointing toward the probability that the American car will win; the American outside cylinders for locomotives are also steadily gaining ground, though English designers are still placing them in an inclined position, and it remains to be seen whether the roundhouse will survive as the fittest shelter for a locomotive, or will be compelled to give way to the running shed.

Much has been said for and against the storage battery at different times during the last few years, and there is one error that many authors have made—viz., not classifying the use to which the battery is to be put, but treating its uses as a whole and attempting to draw conclusions therefrom. The uses of batteries may be divided into two general classes: First, where the weight of the battery is a factor; and, second, where weight may be disregarded. The former mode of application, in which the battery is used for individual motor cars, launches, and the like, have given far from satisfactory results, except possibly in a few special cases, and therefore we will not consider this class. In the second class is the battery in connection with a central station, to take up the fluctuations of load, to keep on supplying energy when the engines are shut down for short periods, etc. Now the question arises, Is the storage battery the best and most economical means of accomplishing this end? or would it be more economical to use some agent other than the battery? The opinion of an engineer is usually strongly in favor of the battery or much opposed to it, few taking up the question on its merits. Among several papers presented to the American Institute of Electrical Engineers on Wednesday, November 20, there was only one, by Nelson W. Perry, entitled "The Storage Battery or the Gas-Engine as an Auxiliary," which took up the question seemingly on its merits.

Mr. Perry's paper, to which we refer, appears in this number.

RAILROAD RACING.

The last number of this journal contained an article with the above title, in which the subject of cars for the fastest trains was discussed. It was there shown that the weight per passenger of the cars in the train which made the fast run between New York and Chicago last September was 1,656 lbs. per passenger, and this was compared with the weight of the cars on the New York Elevated Railroad, which is only 500 lbs. for each seat. The possibility of making cars suited for fast-train service of much less weight than those which are now used was propounded, and it was suggested that "if such a reduction of weight was effected that it would make the problem of increased speed a much easier one than it now is." The discussion of locomotives for such service was deferred and will now be taken up.

The essentials in a locomotive for making fast time are, first, a sufficient load on the wheels to produce adhesion on the rails; second, an adequate supply of steam, and third, mechanism for turning the wheels at the required speed.

There is, of course, no difficulty in having sufficient weight on the driving-wheels, which might be and sometimes is provided by an otherwise useless mass of cast iron made into the form of a foot-board. The trouble usually is, if the boiler is made large enough to supply steam, and the turning mechanism is made adequate to perform its duties, that there is too much weight on the wheels. It is, of course, true, too, that every pound of weight in a locomotive which is not needed for adhesion, the generation of steam, or for turning the wheels, is an impediment and not an aid in making fast time.

If the weight of the cars for carrying 218 passengers was reduced one-half, it could not be assumed that the locomotive for hauling it at a given speed could also be reduced in the same proportion, for the reason that the weight of the passengers would remain the same, and so would their stature, and this requires a certain height and width and space in the cars. Or, in other words, their dimensions cannot be reduced even if their weight is, or, at any rate, it cannot be brought below certain limits. The atmospheric resistance—which is an important element in fast running—could, therefore, be but slightly changed if the trains are made lighter.

The locomotive and tender, therefore, to make, say, 60 miles an hour, with a train of cars weighing 180,500 lbs., must weigh somewhat more than 102,000, or half that of the New York

Central engines—how much more we will not now attempt to indicate. Supposing, though, that we want to make an average speed of 70 miles an hour with our light train instead of 60, what kind of an engine will we need?

It is sometimes hastily assumed that if a locomotive is doubled in size it will run twice as fast. If the wheels were made 12 ft. in diameter instead of 6 ft., and the cylinders and boiler in like proportion, and the wheels were turned the same number of revolutions in a given time, it seems at first as though the speed of the locomotive would be doubled. It is somewhat like the hypothesis that if an elephant could jump as far as a grasshopper does in proportion to his weight, the larger beast could cover many miles in a single leap. The fallacy of this reasoning was pointed out by Ruskin in a note in "Modern Painters,"* in which he said:

"Many persons have thoughtlessly claimed admiration for the strength—supposed gigantic—of insects and smaller animals, because capable of lifting weights, leaping distances, and surmounting obstacles of proportion apparently overwhelming. Thus, the *Formica Herculanea* will lift in its mouth and brandish like a baton sticks thicker than itself and six times its length, all the while scrambling over crags of about the proportionate height of the Cliffs of Dover, three or four in a minute. There is nothing extraordinary in this, nor any exertion of strength necessarily greater than human, in proportion to the size of the body. For it is evident that if the size and strength of any creature be expanded or diminished it can maintain exertion, or any other third term resultant, remains constant—that is, diminish weight of powder and of ball proportionately and the distance carried is constant, or nearly so. Thus, a grasshopper, a man and a giant 100 ft. high, supposing their muscular strength equally proportioned to their size, can or could all leap, not proportionate distance, but the same or nearly the same distance—say 4 ft. the grasshopper, or 48 times his length; 6 ft. the man, or his length exactly; 10 ft. the giant, or the tenth of his length. Hence, all small animals can, *cæteris paribus*, perform feats of strength and agility, exactly so much greater than those to be executed by large ones, as the animals themselves are smaller; and to enable an elephant to leap like a grasshopper he must be endowed with strength a million times greater in proportion to his size. Now, the consequence of this general mechanical law is, that as we increase the scale of animals, their means of power, whether muscles of motion or bones of support, must be increased in a more than proportionate degree, or they become utterly unwieldy and incapable of motion; and there is a limit to this increase of strength. If the elephant had legs as long as a spider's, no combination of animal matter that could be hidebound would have strength enough to move them; to support the megatherium we must have a humerus a foot in diameter, though perhaps not more than 2 ft. long, and that in a vertical position under him, while the gnat can hang on the window frame and poise himself to sting in the middle of crooked stilts like threads, stretched out to ten times the breadth of his body on each side. Increase the size of the megatherium a little more and no phosphate of lime will bear him; he would crush his own legs to powder. (Compare Sir Charles Bell, 'Bridgewater Treatise on the Hand,' p. 296, and the note.) Hence there is not only a limit to the size of animals in the conditions of matter, but to their activity also; the largest being always least capable of exertion; and this would be the case to a far greater extent, but that nature beneficently alters her proportions as she increases her scale, giving, as we have seen, long legs and enormous wings to the smaller tribes and short and thick proportion to the larger."

Suppose that we had two locomotives capable of hauling such light trains as have been suggested at 60 miles per hour, and that two trains ran side by side on parallel tracks, obviously if these two trains and locomotives could be transmuted into one, there would be no mechanical or logical reason why the single or larger train could run faster than the two light ones.

To increase the speed of a train from 60 to 70 miles per hour, let us see what is required. In a table of railroad train resistances, which is perhaps as reliable as any,† the resistance per ton (of 2,000 lbs.) at 60 miles per hour on a level road is given as 27 lbs. At 70 miles it is said to be 34.6 lbs. The consumption of steam, therefore, at the higher speed would be in somewhat the same proportion—that is, it would be as 34.6 : 27. The celebrated No. 999 class of engines, on the New York Central Railroad, have 1,930 sq. ft. of heating surface, and a grate area of 30.7 sq. ft. The half of these two quantities would be 965 and 15.35 respectively. As the amount of steam which will be consumed at the higher speed compared with that required at 60 miles per hour will be as 34.6 : 27, therefore the amount of heating surface and grate area required will be in like proportion, or 1,236 and 20 respectively. It is true that a locomotive with that amount of steam-generating capacity would weigh somewhat more than half as much as the No. 999, which would, of course, increase the total weight of the train, so that somewhat more heating and grate surface would be required for the higher speed with the light train. Such a locomotive could, however, be readily built.

Let us see what would be required if we should attempt to accelerate the speed of the heavy train in like proportion; but before doing so, it should be said that our reasoning is of a hypothetical character, and is not based upon any quantitative data, and is only intended to indicate the principles which must be complied with when the average speed of trains is increased.

If we should attempt to make an engine to haul the heavy train at an average speed of 70 miles per hour instead of 60, or, in other words, accelerate its speed one-sixth, the grate area and heating surface would require to be increased in the proportion of 34.6 : 27, so that we would require 2,473 sq. ft. of heating surface and 40 ft. of grate area. This would, of course, give us a heavier engine, which excess would be added to the total weight of the train, which, in turn, would react on the engine, making some additional weight necessary. It is safe to assume, then, that we would need somewhat more than 2,500 sq. ft. of heating surface; and if the fire-box is constructed as that of No. 999 is made it would require to be about 10 ft. long.

It is submitted that most locomotive builders would rather undertake to furnish an engine to haul the light train at 70 miles an hour than to undertake to make time with one as heavy as the Empire Express ordinarily is. In other words, it is very much easier to increase speed by reducing the weight of trains than it is by increasing the capacity and weight of locomotives. If the report which is current that some of the heavy 10-wheeled fast passenger engines now in use have at times manifested a propensity for leaving the track be true, it may be that that form of construction will not be available if an increase of speed is attempted with such trains as are now employed on the fastest schedules. If not, and faster time is demanded without a diminution of weight of train, the type of engine best adapted to the service becomes a very interesting problem to all designers and superintendents of locomotives.

On another page an engraving is given of the new express engine recently built by the Baldwin Locomotive Works for the Chicago, Burlington & Quincy Railroad, which at this juncture is very interesting. The three essential requirements in locomotives for making fast time, as stated in the beginning of this article, are sufficient adhesion, an adequate supply of steam, and effective rotating mechanism for turning the driving-wheels. In the locomotive referred to the latter are placed under the middle of the boiler, and can therefore be loaded with as large a proportion of the weight of the machine as may be desirable. For producing steam, grate area and heating surface are required. From our illustration it will be seen that the plan of construction shown permits of as wide a fire-box being used as may be desirable, of course not exceeding the total width available for engines and cars. In the present instance the width of grate adopted is 5 ft., so that to have 40 sq. ft. of area, which our calculations show

* Vol. II., p. 57, second American edition.

† See "Catechism of Locomotive."

would be hypothetically required, it would need to be only 8 ft. long instead of 10 ft., as it would be if placed between the wheels.

This plan of engine has also the characteristic that it gives very long tubes. By increasing the diameter of these somewhat, there will be no objection to their use, and a large amount of heating surface will be obtained, which means corresponding steam-generating capacity. The driving-wheels, it will be seen, are placed as near together as their flanges will permit—which gives short coupling-rods and less liability of breaking, which is a constant source of terror to some of us when we are riding on locomotives. The rods, too, it will be seen, instead of being below the cab, as in orginary engines, where they are the most dangerous, are in front, where they will be less liable to injure the occupants of the cab in case they or the crank-pins are broken. The feature in the engine to which there may be some demurral is the single-axle leading truck. There is still considerable doubt in the minds of many locomotive superintendents and master mechanics with reference to the safety of such trucks at high rates of speed. The process of reasoning which leads to this doubt seems to be that a two-axle or four-wheeled leading truck has been proved by long experience to be safe, and the inference is then drawn that if there is only one axle, there will be only half the safety. It would lead us too far now to examine the premises and the deduction which leads to this conclusion. Mr. Rhodes, however, after years of experience with mogul engines on his road in fast-express service, has ordered the engine which is illustrated in this number. He is a cautious man and generally sound in his conclusions, and has apparently acted with the approval of his superiors. Then, too, there is the fact that there are hundreds or thousands of mogul and consolidation locomotives employed in freight service, in which they often run at high rates of speed, and we have never heard it even hinted that they were not as safe in that service as 10-wheeled or decapod engines. It has been argued, and very plausibly too, that if a single-axle truck is properly constructed, it is *safer* than one with four wheels, and if the reported derailments of 10-wheeled express engines is confirmed, it adds plausibility to that conclusion. Anyway, the railroad public will be interested in learning the results of Mr. Rhodes's experience with his new engines.

Again our subject has extended beyond our limits and may be taken up again in the future.

THE MOST ADVANTAGEOUS DIMENSIONS FOR LOCOMOTIVE EXHAUST-PIPES AND SMOKE-STACKS.*

By Inspector Troske.

(*Continued from page* 543.)

II. THE HANOVER EXPERIMENTS (1892–94).

These experiments were suggested by the fact that a newly constructed high-speed locomotive was an exceedingly poor steamer, and that the usual remedies made only a very slight improvement. In order to ascertain the reason for this phenomenon, Herr von Borries, the Superintendent of Motive Power of the State Railways, decided to make a special investigation with different shapes of smoke-stacks, and had made for that purpose the apparatus illustrated by fig. 12. The author of this paper was intrusted with the execution of these investigations. They were commenced in the summer of 1892 at the main workshops of the railroad company, and continued on until the autumn of 1894.

The apparatus used is shown in fig. 12. It consists essentially of a lower steam chamber and an upper air chamber. The steam pipe with a diameter of 6.3 in. passed air-tight through the plate separating the two chambers and carried the nozzle at its upper end, this piece having an opening ranging from 3.9 in. to 5.5 in. The stacks subjected to the investigation had a diameter of 17.7 in., and were placed over the circular opening cut in the top sheet of the air chamber. On the four sides there were four air valves of the same size. It was the original intention to investigate the effect of various positions of the nozzle relatively to the lower end of the stack, and to do this by raising or lowering the nozzle through the means afforded by the apparatus illustrated in fig. 12. But it developed that when the nozzle was in its lowest position, the air chamber itself acted as a sort of stack, and it became possible, with the stack removed, to obtain a vacuum equivalent to $\frac{1}{4}$ in. water pressure.

In order, therefore, to render exact work possible, and for which purpose it became necessary to place a cap over the mouth of the pipe leading from the boiler, the location had to be obtained by more convenient means. The distance of the nozzle in question could then be changed without actually altering the position of the nozzle itself by changing the position of the stack by putting welded rings in between its foot and the air chamber. These rings were welded out of $\frac{1}{2}$ in. plates and were of the form shown in fig. 13. There were 10 of these rings, starting with one 1.57 in. in height and increasing in height by 1.57 in. By setting several rings on top of one another the distance of the nozzle from the lower end of the stack could be increased up to 30 in. or more.

During the tests the joints between the rings were kept well smeared with a paste, so that they were kept air-tight. The four air valves were so adjusted for the admission of the outer air that their combined free area amounted to 14.65 in. $\times$ 5.51 in. = 80.72 sq. in. This latter had previously been determined on a standard passenger locomotive in the following manner: After loosening the slide valve and then fastening in another in such a way that the steam ports were closed, a mercury manometer was connected with the empty steam chest of the locomotive and then enough steam was admitted through the throttle valve, the depth of the fire being the same as that ordinarily carried on fast runs, to produce a vacuum of 3.94 in. of water in the smoke-box as indicated by the water column attached thereto. The corresponding readings of the mercury manometer that measured the steam pressure were noted, and this was repeated several times until a whole series of results was obtained, and then an average was taken. Then a blast nozzle of the same size as that used upon the locomotive was placed upon the apparatus, and steam admitted until the mercury manometer indicated the average pressure that had been obtained by the previous experiments, when the air valves were so adjusted, the same amount of opening being left in each, that the vacuum indicated by the water column amounted to 3.94 in. This was then made the basis of the experiments which were thus warranted to correspond closely to actual practice. As a matter of fact also, as we have already remarked, the different shapes of stacks that were investigated with the valves in these positions were frequently transferred afterward to locomotives under steam and made fast, where precisely the same results were obtained. In consequence of the uniformity of results, the slight difference which existed between the steam measurements in the steam-chest and the apparatus due to the greater freedom of steam flow in the latter seems to be a matter of no moment.

The position of the four air valves being thus ascertained, the experiments were then carried on, admitting cold air into the chamber, while, in the actual work of a locomotive, it is well known that the temperature of the hot gases coming from the fire-box range from 575° to 840° F. Afterward similar experiments upon a running locomotive showed that the difference between the same shaped current of steam as applied in the apparatus or upon the standing locomotive and the steam acting intermittently upon a fast-running locomotive is of no importance whatever as far as the action of the stack is concerned, and though this is not the case with slow-moving locomotives, it is in no way troublesome to make a transfer or application of the results obtained with the experimental apparatus. It has already been stated here that isolated experiments with the apparatus in no way serve to establish the formula for the laws of actual service, but that these can only be fixed by experiments with running locomotives.

The next thing to establish was, how smoke-stacks of different forms would act with respect to the creation of the draft. Here it is a matter of slight importance whether the values of the vacuum obtained are in exact correspondence with the values observed on running locomotives or not.

In all the experiments with the apparatus the aforesaid positions of the air valves were left unchanged, hence the sucking

* Paper read before the German Society of Mechanical Engineers.

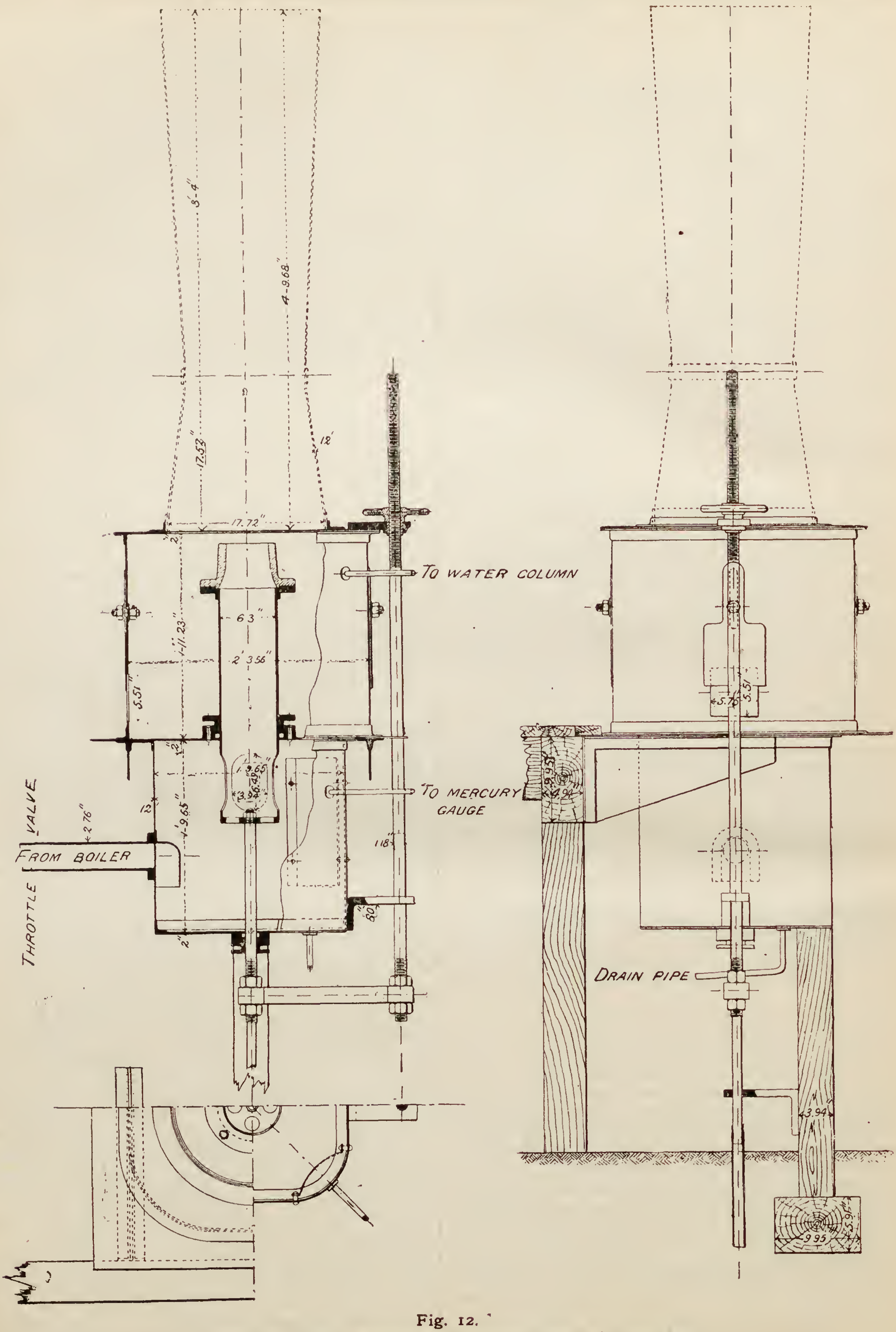


Fig. 12.

APPARATUS USED IN THE HANOVER SMOKE-STACK EXPERIMENTS.

action of the steam current could not be clearly shown for the different relationships, but only on locomotives of prescribed limitations. Moreover, though the experiments had already occupied so much time for the establishment of this basis, and though it was necessary for them to be carried on at spare intervals, it was very evident that they must be extended still

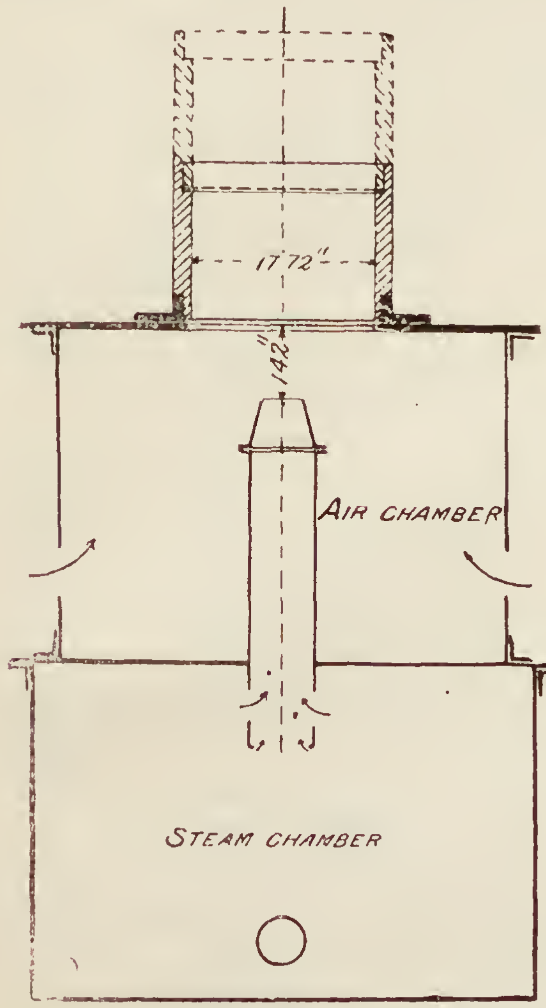


Fig. 13.

further in order to investigate the effects of varying the size of the air openings. These experiments were made with blast nozzles of five different diameters and 18 different smokestacks taken from locomotives of ordinary proportions. The dimensions and shapes were :

(*a*) Five different blast nozzles of 3.94 in., 4.33 in., 4.74 in., 5.12 in. and 5.51 in. in diameter as shown in fig. 14.

(*b*) Five cylindrical stacks of 13.78 in., 14.76 in., 15.75 in., 16.73 in. and 17.72 in. in diameter as shown in fig. 15.

(*c*) Conical-shaped stacks with converging top and bottom inclinations of $\frac{1}{12}$ * and minimum diameters of 11.81 in., 12.8 in , 13.78 in., 14.76 in. and 15.75 in. as shown in fig. 16.

(*d*) Five conical stacks with an inclination of $\frac{1}{6}$ and the same minimum diameter as shown in fig. 17.

(*e*) Three funuel-shaped stacks (without a waist), of which one had an inclination of $\frac{1}{6}$ and a minimum diameter of 13.78 in., and two having inclinations of $\frac{1}{12}$ and minimum diameters of 13.78 iu. and 15.75 in. as shown in fig. 18.

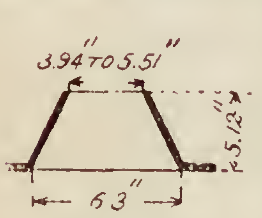


Fig. 14.

In the steam pipe leading from the boiler to the apparatus, which had a diameter of 2.76 in., a cut-off valve a throttle valve and a metallic manometer were placed. The throttle valve was fastened in a convenient position near to the apparatus where a wooden booth was set up, in which the measuring instruments were placed and from which the apparatus itself could be readily watched through a window. A readiug of the instruments in the open, while the apparatus was in blast, would not have been possible, since the outrushing steam made an ear-bursting racket and the stack emitted the hot condensation of the steam, while showers of water prevailed all about.

Before an experiment began the apparatus, whose steam chamber was well protected by a thick layer of felt against cooling, was thoroughly warmed. The water of condensation of this chamber was carried off by a pipe that was left open during the experiment. By means of the throttle valve the pressure in the steam chamber was kept at the same height

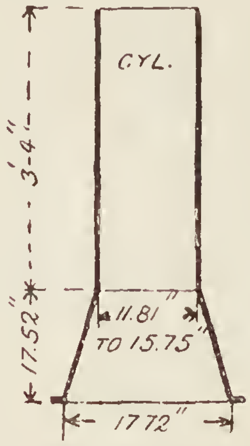


Fig. 15.

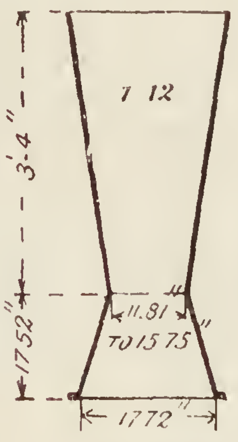


Fig. 16.

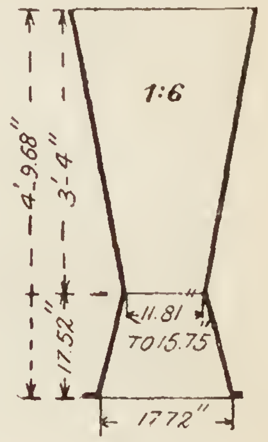


Fig. 17.

while the blast was in operation. The metallic gauge served to indicate the pressure existing in the boilers which was held within the limits of from 67 lbs. to 75 lbs. per square inch. In order that this great outpouring of steam might be maintained it was found necessary to force all three boilers of a neighboring battery up to their full power, though ordinarily they served to supply steam to a small steam engine and several steam hammers. With only two boilers in service, though the fires might be burning briskly, the steam pressure would gradually drop as much as .4 in. in the mercury column, which rendered accuracy in the results impossible ; though this same variation was not observable in the metallic gauge. This is offered in explanation of the contradictory results ob-

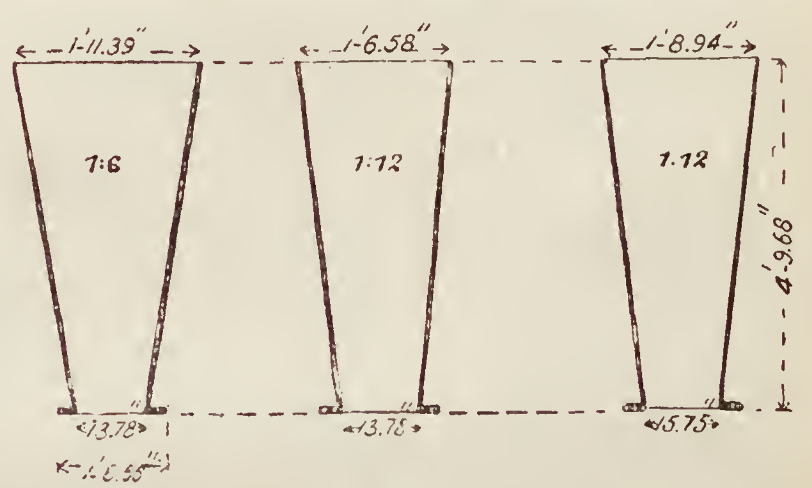


Fig. 18.

tained by the Prüssmann experiments. While with him the pressure of the very small amount of steam emitted was measured by a sensitive instrument, the small variations of boiler pressure were allowed to pass unheeded, though they had the greatest influence upon the amount of steam emitted ; in the Hauover experiments the great outflow of steam was controlled by a delicate instrument. In consequence of the latter condition and the making of a great number of observations, for in all more than thirty thousand readings were taken, the values obtained showed a very uniform course when plotted in the form of a diagram. The variation of the maximum and minimum values from the basis established by the general average was, in the majority of cases, about .04 in. at the most, and seldom ran as high as from .08 in. to .12 in. The observations repeated in different months gave the same ratios with the same stacks, and always the same vacuum was reproduced. The temperature of the air only had an influence upon the results in so far as that the readings taken during the colder months for each position of the blast-pipe fell from .12 in. to .2 in. lower than when the weather was warm, due to the fact that the current of steam clung more closely to the sides of the stack. This affects, then, only the boundary limits of the dropping ends of the curves, and consequently the position of the nozzle, which is not changed in practice, and is, therefore, of no importance in connection with the respective stacks.

We next took up the task of establishing the relationship existing between the pressure in the blast-pipe and the vacuum.

* By "inclination" the inclination of the two sides of the cone is meant; each side naturally has, therefore, but one half the above-stated inclination to the vertical. If the inclination of the stack is considered to be n, then one side of the cone will be $\frac{n}{2}$; if the length of the stack be considered to be l, then the upper diameter of the stack will be $\frac{l}{n}$ greater than the smallest diameter. For example, if we have a stack 3 ft. 6 in. long, with an inclination of $\frac{1}{12}$, we have an increase of diameter of $\frac{42}{12}$ = 3½ in., or, with an inclination of $\frac{1}{6}$, an increase of $\frac{42}{6}$ = 7 in., etc.

Already in his experiments with a locomotive under steam but stationary, Clark had obtained results sufficient to prove the proposition that the vacuum stands in a direct ratio to the blast-pipe pressure. This was investigated with the apparatus with stacks having the greatest variations of diameter and length and with all five of the blast nozzles, and was found to be in exact correspondence in every instance.

If we take the blast-pipe pressure as abscissas and the corresponding vacuums as ordinates, the end points of the latter will form straight lines. In figs. 19 to 23 these diagrams are given for the operation of a stack having a diameter of 13.78 in. The blast-pipe position for all 15 of the readings was the same, or 1 ft. 10 in. Equal abscissas correspond to equal steam pressures. If the latter were twice, four times, or five times as great, the vacuum would increase twofold, fourfold, or fivefold, as the case might be.

The amount of steam issuing forth increases as the diameter of the nozzle is made larger, about in the ratio of the square of the diameter of the nozzle. If we consider that the amount of steam issuing from a nozzle 4 in. in diameter to be equal to 1, it follows that, with the same steam pressure and a

Nozzle diameter	= 4 in.,	the steam delivered			= 1.00
"	" = 4.4 in.,	"	"	"	= 1.21
"	" = 4.8 in.,	"	"	"	= 1.44
"	" = 5.2 in.,	"	"	"	= 1.69
"	" = 5.6 in.,	"	"	"	= 1.96

Notwithstanding the fact that with a nozzle diameter of 5.6 in., nearly twice as much steam is delivered as would be through one only 4 in. in diameter, a casual comparison of these five diagrams shows that the vacuum rises in a far smaller ratio.

To make this still clearer, the following figures are brought together:

TABLE I.

Diameter of Stack.	Shape of Stack.	Increase in the vacuum with the nozzle located at 22 in., if the nozzle diameter is opened from 4 in. to 5.6 in.
13.78 in.	Cylindrical	From 4.08 to 4.6 in. = .52 in. = 12.7 per ct.
	Conical $\frac{1}{12}$	" 3.96 " 5.14 in. = 1.18 in. = 30.7 "
	Conical $\frac{1}{6}$	" 3.4 " 4.84 in. = 1 44 in. = 42.3 "
15.75 in.	Cylindrical	" 3.58 " 4.42 in. = .84 in. = 23.4 "
	Conical $\frac{1}{12}$	" 3.08 " 4.36 in. = 1.28 in. = 41.5 "
	Conical $\frac{1}{6}$	" 4.88 " 3.78 in. = 1.1 in. = 52.4 "

Hence, if the outflow of steam increases by about 100 per cent., the vacuum (under this ratio) will increase about 52 per cent., the shape of the stack remaining the same.

From these five diagrammatic representations we can readily see, without any further demonstration, how a cylindrical stack having a diameter of 13.78 in. falls off in its action with the same amount of steam as compared with the conical stack. With a nozzle diameter of 4 in. the cylindrical form seems to be the best when taken in connection with the height of the vacuum; at a diameter of 4.4 in. it nearly coincides with the conical form having an inclination of $\frac{1}{12}$; with a further opening of the blast nozzle it drops down below the last-named form, until at a diameter of 5.2 in. for the nozzle it has fallen even below the stack having an inclination of $\frac{1}{6}$.

In other respects the diagrams show that the action of the cylindrical stacks is very much better than that of the conical if we take stacks having a larger diameter than 13.78 in. It so happens, then, that under the same ratios as shown in figs. 19 to 23, that with stacks having a diameter of 14.76 in., the cylindrical stack first coincides with the conical stack having an inclination of $\frac{1}{12}$ when the nozzle has a diameter of 5.06 in. With a diameter of 15.75 in., as well as with all five diameters of nozzle, the cylindrical form is superior to the conical (the nozzle position being 1 ft. 10 in.) as is shown by figs. 24 to 28.

We next have to show the reason why we believe, from the results obtained from the experimental apparatus, that a cylindrical stack 13.78 in. in diameter and 4 ft. 9.68 in. high is too small to be used with a nozzle 4.33 in. in diameter, just as a stack of 14.76 in. in diameter is too small for a nozzle having a diameter of 5.06 in. or more. And we are inevitably led to the further conclusion that the cylindrical stack, as being also superior at the smallest cross-section, must be preferred to the conical stack if we expect to maintain the same vacuum with the two forms under the same conditions. Likewise the conical stack should be given different inclinations, and the narrow inclination of $\frac{1}{12}$ be increased to $\frac{1}{6}$, as shown latter in Section X.

Finally, we can state, as a well-defined conclusion, that the blast-pipe pressure has no influence upon the form of the stack, a conclusion that Prüssmann has already announced as the re-

Fig. 19.

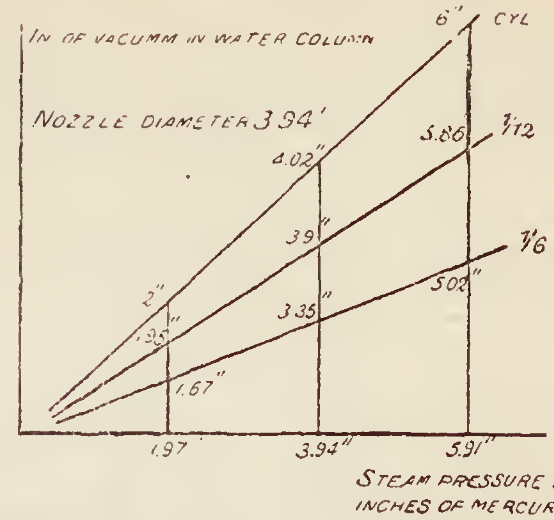


Fig. 20.

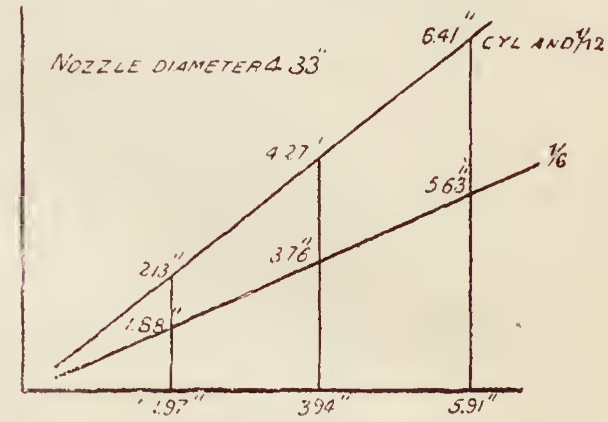


Fig. 21.

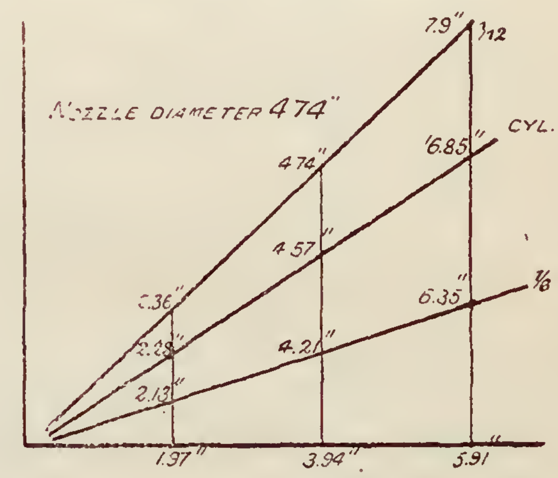


Fig. 22.

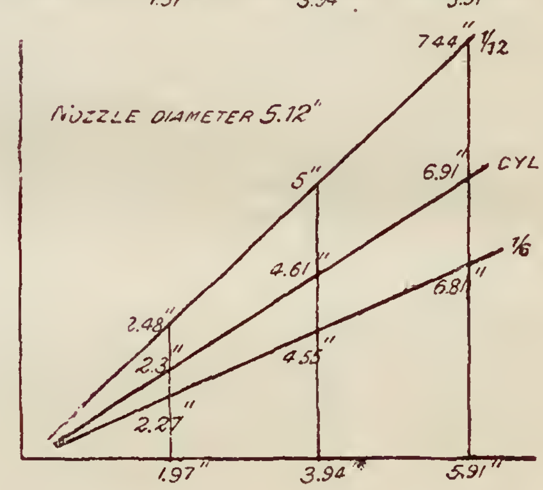
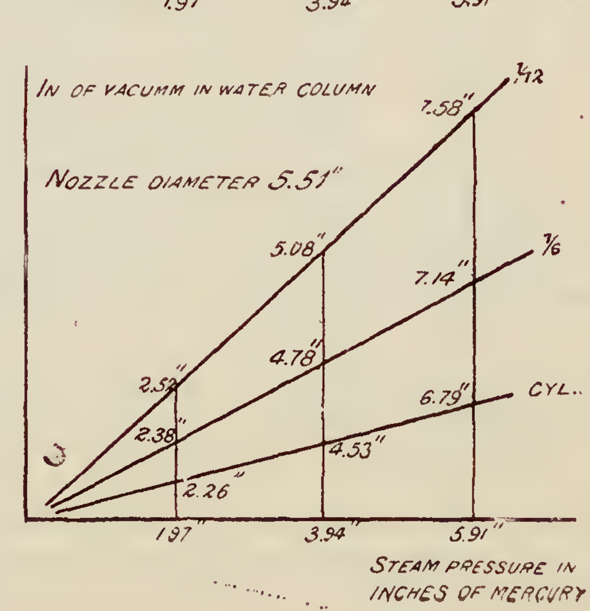
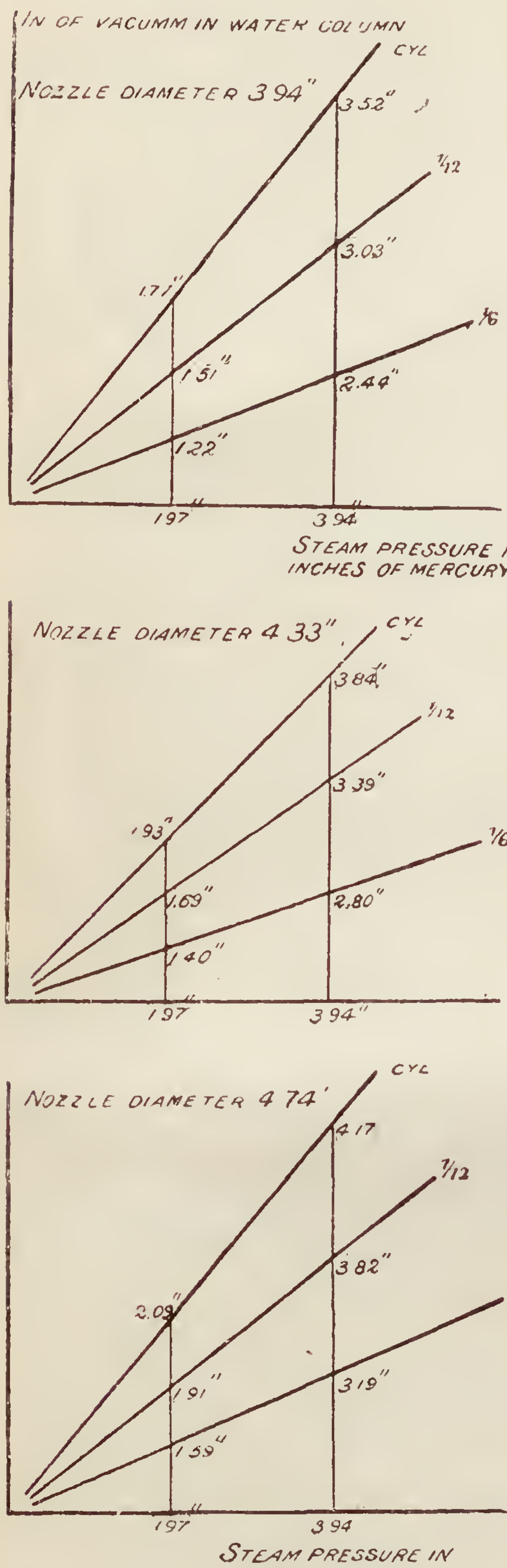


Fig. 23.



sult of his experiments. Figs. 19 to 23 and 24 to 28 show this to be the case without the necessity of any further references ; for the trend of the vacuum lines for the three different shapes of stacks maintains the same relationship to each other for all blast-pipe pressures, the nozzle diameters remaining the same. This position permits one to choose any steam pressure that may be desired for the experiments, even though it may not exactly correspond with the blast-pipe pressures as they exist in the locomotives. The Hanover experiments were now conducted with a steam pressure of 3.94 in. of the mercury column, a value which, as was afterward established, corresponded almost exactly with that existing on the standard passenger locomotives when running at a speed of from 34 to

Figs. 24 to 26.



37 miles per hour, a cut-off at .2 stroke, and exhausting through a nozzle of 4.74 in. in diameter. All of the experiments with the 18 stacks, of which 15 were in four different lengths, were made with this steam pressure, the openings into the air chamber remaining the same, and all other conditions being unchanged.

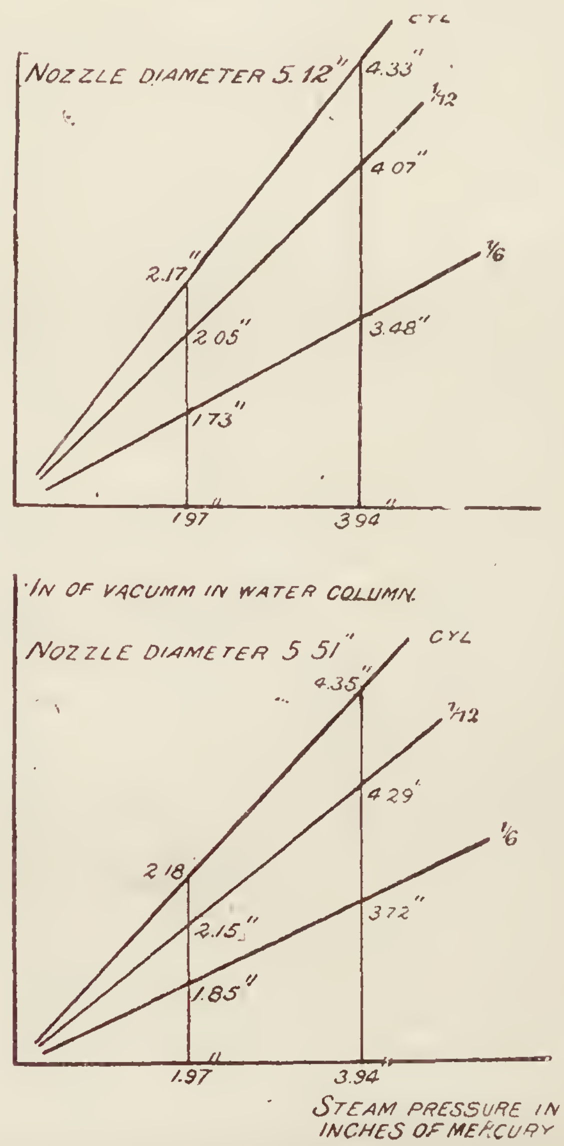
Each stack was tested with five different diameters of nozzle openings. In all there were 320 different combinations of stack and nozzle relations tested. In each of these relations there were at least 10 different positions of the nozzle employed and as many curve points marked with each six readings for the purpose of reaching a definite conclusion.

(TO BE CONTINUED.)

SOME DIFFICULTIES OF ELECTRICAL RAILROADING.

It goes without saying that the application of electricity to the propulsion of street cars has made most marvellous advances during the past nine years, when it received its first really successful application. But if we can believe the testimony of the experts who have spoken upon the subject, all is not smooth running, and the lot of the superintendent of repairs is not a happy one. A certain king, we are told, once made an attempt to run a number of clocks in exact unison, and made such a failure of it that no one has since had the courage to so much as make the attempt until the electricians started in to do practically the same thing by putting two motors upon a single car and hoping, though they knew that there was no ground for expecting a realization of their hopes, that all would would work well and satisfactorily. This and the difficulty existing in the present use of gears for transmitting the power from the armature shaft to the axle are the two great bugbears of electric traction. That there should be a difficulty with the latter is not at all surprising when we consider the location in which they are placed and the usual condition of that location, besmeared and bespattered as it is with mud and dirt.

Figs. 27 and 28.



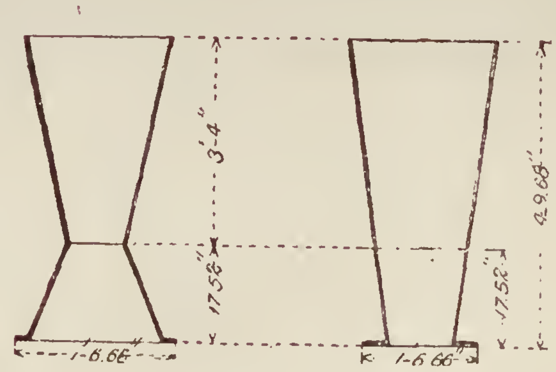


Fig. 29.

The first cars were driven by sprocket wheels and chains with the motors on the platform, but this system was soon abandoned for the method now used, and which has all along been considered as unsatisfactory. As long ago as in 1890 Dr. Louis Bell, in speaking on the subject, said : "At present nearly all electric cars are operated by plain-toothed gearing. In the existence of this lies one of the difficulties that must be overcome in the future. To-day the grinding gear wheels underneath the car constitute the most serious mechanical difficulty in electric railroading, and it should be the object of inventors to dispense with them if possible. They rattle and grind and squeak, teeth break, bearings get hot, and there is no man who is practically acquainted with their manifold failings but heartily wishes them out of the way, and few people have any idea of the mine of power that these grinding cog-wheels waste. Most of our present electric cars have two motors, each with its appropriate set of gears, and it is an unfortunate fact that these two do not always pull together in the harmony that might be desired. There is a constant tendency for one of them to do more than its share of the work,

and aside from this, the two sets of gears consume an outrageous amount of power, which, it should be remembered, does not go into useful work, but simply tends to heat and wear out the running parts. It is pretty clear that there is a disadvantage in the use of two motors, except in so far as it is convenient to drive both axles for ease of ascending grades, and it is no less evident that a considerable power can easily be lost in gearings. We may hope in the near future to have a system of motor cars in which considerably less power will be required than at present, and this by the simple but somewhat difficult process of simplifying the running gear."

Again, two years later, in a discussion on the subject before the American Institute of Electrical Engineers, it was stated that the gears used waste "30 per cent. besides by grinding themselves to dust, and how much the losses are in high-speed gearing nobody knows." At the same time, a case was cited of an English system where with very carefully cut zig-zag gears the loss amounted to as much as 40 per cent., and it was added that "street-car gears must be very wasteful, not only because of the rough usage they are exposed to when going through rain and dirt and over dusty roads, but from the fact that the transmission of power by gearing is at the best only when the height of the gear teeth is negligently small compared with the radius of the gear. But the high-speed gearing pinion must necessarily be small, and then the height of the teeth is very perceptible compared with its radius. In this case the gearing does not transmit with a fixed but with a varying ratio. The teeth touch each other first with their heads, slide over each other and come out of impact when touching each other with their feet. That means that the ratio of transmission for each tooth which passes another varies between the ratio of the maximum and the minimum radii of contact.

"Thus, suppose the pinion has 16 teeth, the motor revolves at the rate of 1,200 revolutions per minute. Then 10,200 times per minute the leverage of transmission goes up and down. This is what causes the rattling and hissing noise of high-speed gearing and their rapid destruction. That the loss of energy in the gearing is considerable we can see without any tests if we consider in what very quick time steel and phosphor bronze pinions are ground to dust and rawhide gears torn to fibres. For the law of the conservation of energy teaches us that where a display of energy takes place, a corresponding consumption of energy exists, and if such tremendous energy is set free as to grind steel and bronze to dust and to chop rawhide pinions rapidly into fibres, the consumption of energy must be correspondingly large and the only source of energy is the motor."

A third difficulty of a purely mechanical nature is to be found in the method of supporting the motor upon the axle. The tail is usually carried by some elastic support, but the main body and weight of the motor is carried by bearings resting directly upon the axle, and consequently liable to all of the thumping and pounding of the wheel upon the rail. This naturally works to the disadvantage of both the rolling stock and permanent way; the constant jolting disturbs the action of the motor, and the heavy, uncushioned pound of the latter upon the joints has compelled street railway companies to resort to the use of a rail that has a vertical stiffness fully up to that demanded by heavy-traffic steam lines, though the weight of load per wheel is insignificant as compared with that to be found on locomotives, thus showing that the so-called locomotive hammer-blow is not the worst of all evils in the maintenance of proper track alignment. An attempt has therefore been made to mitigate this trouble by remodelling the design of the motor, and one has been brought out which is so suspended that, for a machine of 25 H.P., only about one-third of its weight has been thrown upon the axle, and it rests upon a spring like cushion which obviates the chance of accident to the axle and lessens the pounding upon the track.

When this motor was first presented it was stated that the modification embodied in it would have a great influence in doing away "with the tremendous hammer blows upon the track. If the difference in dollars and cents per year expended in road repairs between a system having 2,500 lbs. over each car axle and one having 500 lbs. could be determined it would be a startling exhibit. Railway managers are aware of a constant need of heavier rails, and they can only account for it by concluding that the increase of car service, coupled with the additional weight on the axle incident to electric railway traffic, has never been sufficiently provided for by electrical engineers. In all double-motor equipment the weight on each axle is very large. So it will be seen that this modification in the system of motor suspension is of significance in electric railway practice. The greater part of the dead weight is more evenly distributed to the axle bearing and that part of the truck which can better stand the strain. This means greater economy in track maintenance and a decrease in the possibility of accident to the axles."

Then we come to the car wheels. That the wheels under street cars should wear more rapidly per mile run than those upon steam lines is evident from the fact that they run with the brakes applied for a great portion of the time, and that these brakes are, from the very conditions of the service, well supplied with an abrasive in the shape of sand. To pass from the horse car to the one driven by electricity, we find the conditions still worse, for when the brakes are not applied the wheel is acting as a driving-wheel upon a track that is always sanded. "These wheels are constantly slipping, even upon straight tracks. Take the ordinary car with two motors. It will have a wheel base of 6 ft. or 6 ft. 6 in., with a 20-ft. body. When in operation, and especially if loaded at the two ends, the overhanging weight causes teetering or galloping. This motion alternately imposes extra weight on one wheel, while the load upon the other is diminished. As the load is lightened the traction of the wheel diminishes, and since the motive power remains constant, there is a certain amount of slipping, while the other pair of wheels do more than their share in driving the car. The next instant the motion reverses the conditions, and the other wheel slips. This slipping, due to teetering, seems to be almost constant upon some roads. In addition to this, the wheels frequently slip without moving the car, and this slipping is sufficient to account for a large proportion of the unusual wear of the driving-wheels under trolley cars."

This rapid wearing of the wheels is a serious matter when viewed from the standpoint of repairs, aside from the actual cost of the new wheel, for "no car wheel can be replaced to any advantage without taking out the truck, pressing off the wheel, pressing another on, replacing it in the truck, and replacing the truck under the car. The expense of replacing one wheel has been variously estimated at from $2, in steam railroad service, up to $10 in street railroad service, where the motor has also to be removed and the gear taken from the axle."

Such are some of the mechanical woes of the electrical railroad man. To quote again from Dr. Louis Bell: "It is evident enough that the gain due to the abolition of gearing in the gearless motor is sufficient to compensate for no small loss of electrical efficiency," and he then proceeds to demonstrate that there would be a great saving effected by the use of a single motor and the abolition of one set of gears, and this position is supported by "many engineers who object on theoretical grounds to the use of two motors under any conditions, on account of the tendency of any two armatures to work out of unison if there happens to be any disparity between them, either in the armatures themselves or in the strength of the fields in which they revolve. It is very evident that if the two motors fail to work in the most perfect unison, the resultant effect will be less than it should be; that the perfect unison of action between two separare motors so essential to the highest efficiency of operation is practically unattainable, and is admitted by all."

Extraordinary differences in efficiency have been found by various experimenters between the use of two motors and one, and that the former "diminishes the efficiency to an amount as high as 60 per cent. or more"—a difference which can be partially explained by "slipping and skidding frequently repeated and which are not directly perceived. But an aggravating cause lies in the difference in magnetic fields. Thus, when slipping occurs, one or the other of the motors increases its torque in order to overcome the total resistance which it has to encounter independently of the other; while, when either motor is subjected, by slipping, to a resistance less than the normal, the other motor is affected by the feeble resistance, and tend to stop in unison with the resistance which they encounter themselves, permitting the first motor to turn alone, whether at rest or at any speed. With the motors disposed of in parallel, cases of partial slipping are not excluded."

These are some of the mechanical difficulties that are and have been attracting the attention of street railway men, and it is difficult to see just how a combination can be designed that will obviate all of the troubles that exist. The gearless motor does away with the gearing, but it does not seem to have made much headway in general and extensive application, probably from the fact that it is better adapted for long-distance and interurban service than for the traffic of a town, with the frequent stops and constant changes of speed. And the gearless motor does not lessen the difficulty of the weight on the axle, but rather aggravates it, besides adding to the cost

of the removal of wheels. That the problem will be so solved that all of the difficulties will be removed does not appear to be the promise of the immediate future, but that the evils complained of will be at least mitigated sceems to be in the line of general development, and should be the natural result of the efforts that are being made.

THE OCCUPATION OF AN ENGINEER.

Mr. Archibald Denny, in a presidential address recently delivered before the Institution of Junior Engineers, dwelt upon the occupation of the engineer, and especially upon the education that should be given him in order to fit him for his work. He prefaced his remarks by stating that what he might have to say would have especial reference to ship-building and marine engineering, but that it would also find an application to other branches of engineering. He deprecated the extensive courses in Latin and Greek that are given, and then entered upon his subject by a reference to mathematics.

"Mathematics—at least the elements of it—and the elements of mechanics, chemistry, and physics, should be thoroughly mastered, so that at the age of sixteen, or at the latest seventeen, provided the boy's physique is fairly developed, his apprenticeship might begin. Now, I think it must be beyond dispute that given a lad who intends to tread the higher walks of the profession, and not merely to begin and end as a workman, it is not necessary that he should spend five years at the bench to learn his trade, to gain sufficient expertness in handling the tools and to study practically the qualities and properties of materials; hence my ideal course is as follows: Begin by spending alternately six months—the six summer months—at the bench, and then six months—the winter months—at a first-class technical school or college. As the college or technical school course is generally one of three years, at the end of this time, or in four years at most, the youth should have had enough of the bench and should be quite ready for the drawing-office; the shorter period should suffice in the ship-building-yard and the longer period for the marine engineer. If a ship-builder, then he must remain in the drawing-office or fight his way up through manager to principal as his ambition, opportunity and ability lead him. If a marine engineer, then after a year or two in the drawing-office he should certainly proceed to sea, and if possible get his chief and extra chief's certificate, and thereafter work his way upward on shore.

"This is my ideal course roughly sketched, and one which is being followed out in our yard and engine works whenever possible. Of course every man cannot afford, or has not the opportunity of following out this course; then all that can be done is to study in the evening—not to too late an hour—and take evening classes. Some of our most brilliant men have succeeded in this way alone, but who can say what they would have been if they had had the advantage of such a course as I have sketched out? Endeavor to be apprenticed, if possible, to a firm who do not take premium apprentices. The policy of taking premium apprentices is, in my opinion, a mistaken one, both for the employer and the apprentice. The foremen in the works, and heads of departments generally, have the feeling that premium apprentices must be more leniently treated than the ordinary apprentice, and this feeling is sometimes so strong that we need not wonder at it reacting upon the premium apprentice, and inducing a state of indifference in those who do not start with strong moral fibre. If there are many premium apprentices their effect on discipline in the works must be detrimental, and even supposing that a few out of the many have a higher ideal than their fellows, it is difficult for them to strike out a different course of action from that of the majority. Not having had personal experience of premium apprentices, my views upon this subject may be rather strong, and I know that many young men find it impossible to learn their profession by any other means, but I think it would be an improvement if firms who do take premium apprentices made it a rule that these apprentices were to be treated in exactly the same way as ordinary apprentices, paid the same wages, expected to fulfil the same conditions, and to be advanced only as a reward of real merit. In that case the premium apprentice would either, as the result of lack of application, simply finish his time an ordinary workman; or, as it should be, his superior initial education, with equal application, would ensure his being advanced more rapidly than those who started with fewer advantages, through the drawing-office to a position of trust. I have great sympathy with premium apprentices. I think their surroundings render it difficult for them to do their duty, and the spur of necessity is lacking in many cases, but this is all the more reason why I should point out the dangers, and impress the necessity for facing the difficulties and dangers of the position with a strong determination to overcome them.

"During apprenticeship a lad will doubtless have many opportunities of bringing himself prominently, by good work and conduct, to the notice of his employer and foreman, but while he should seize every favorable opportunity of doing so, he should avoid making himself objectionable by pushing himself forward in season and out of season. To do so will only disgust his superiors and gain him the dislike of his fellow-workmen. Favorable opportunities of bringing himself before the notice of his employer will occur most frequently when in the drawing-office, and the best opportunity is when he is given a piece of investigation work involving probably the carrying out of experiments. If any of you are ever in this position you should be most careful in carrying out the experiments; only draw conclusions after these have been confirmed by a frequent repetition of experiments. Some men have a natural bent toward experimenting; it seems natural to them to tabulate an experiment in the best possible way, and their work at completion is so thoroughly well digested that the results are easily assimilated by the principal, and hearty commendation follows. Under these circumstances it is certain that this man's services will be frequently requisitioned; he is thus brought in close contact with the principal, and his rapid advancement ensured. Such cases have often occurred in my own experience. The careful and accurate man appeals to one immediately, and if this is combined with rapidity in carrying out work, his services are highly prized.

"Another point I want to notice, and one which has been already touched upon by a recent president, is the question of loyalty to your employers. Undoubtedly this is one of your first duties, and a duty that you owe not only to your employer, but also to yourself, because an act of disloyalty to your employer is really an act of degradation to yourself, even if not found out, a constant repetition of which will so undermine your moral character that you become an object of contempt to yourself, which appears to me a more serious thing than being an object of contempt to your fellow-men; indeed, the latter only becomes possible long after the former is an accomplished fact. I know it is the practice of many draftsmen to appropriate information from the drawing-office in which they are employed, to copy plans and tabulated data. Now this, in my opinion, is immoral, besides which I consider it, so far at least as plans are concerned, and also as far as a good deal of tabulated data is concerned, a great waste of time. I have a friend who was once a draftsman, and he has told me that there are now in his possession many plans cribbed in this way, and that he was incited to do this by the needless prohibition and difficulties placed in his way by a suspicious employer. As a matter of fact, he did not gain any advantage from this, as from the day he cribbed them till now they have never been looked at.

"Progress is so rapid nowadays that the mere copyist will always be left behind, and if a man has not sufficient ability from his past experience to scheme out improvements, he will soon be left in the rear along with his cribbed information. May I read you a few sentences from the general order book in force in our yard? 'As there is growing in our office a large amount of special and organized information procured and organized at considerable expense by us, it must be clearly understood by every member of our staff that we consider this information private, and to be used only in our service. Any member of our staff found copying or removing any of this special organized information will be considered to have acted against honor, and will, on our coming to know of his action, be immediately, and without further warning, expelled from our offices. To such a person we will decline to give either reference or character. We consider that the opportunities afforded to the members of our staff in their ordinary work and for private study by our library are sufficient to enable them to acquire a knowledge of all methods of working by means of which, should they leave our service for that of some other firm, or to start on their own account, they can collect and organize information for their employers or for themselves. There is, therefore, no excuse for their acting against honor in the way we have now forbidden.'

"I think these sentences put the matter very clearly and fairly, and may assist young men in deciding upon their course of action. I would, therefore, counsel you to gain experience and store it in your brain, and make notes only of such general principles as you find in use or discover for yourselves, and do not run the risk of lowering yourself in your own estimation by taking that which is another's. You should be absolutely loyal to your employer while with him, identify yourself with

him in every way and make his interests yours, and when you leave one employer to go to another you should carefully consider how much special information you shall impart to your new employer, more especially if he happens to be a rival to your last.

"I would like to give another warning to young men. Cases have come to my knowledge where foreign competitors have by specious promises induced able young men to leave the employ of a specialist in this country, so that he might assist a foreign rival in establishing a similar business abroad. The object was perfectly apparent and was recognized by both parties—I mean both the foreigner and his dupe. A much larger salary was fixed than he was in receipt of previously, with an agreement for a certain term of years. Everything went smoothly until the information possessed by the young man was transferred to his new employer, and then the position became uncomfortable—in fact, so uncomfortable that long before the expiry of the agreed-upon term of years the young man was glad to leave and return to England, sadder and wiser.

"A last hint, and one which I have often found it necessary to give: Hold your tongue about what goes on inside the drawing-office, especially in regard to proposed work. It frequently happens that from the lack of this precaution, information passing from one drawing-office to another induces competition of an unfair nature which otherwise might have been avoided. Now, if you become chief draftsman you will for the first time have control of a number of other men, and you have added to you a serious responsibility in the management of them. Some men are by nature fitted to rule others; other men, good men no doubt, are by nature quite unfitted to do so, but much can be done to correct this latter imperfection. Constant remembrance of the golden rule, "Do as you would be done by," will help; treat those under you with kindness and justice, but at the same time you must be firm in enforcing rigid discipline. One fault which principals find it difficult to excuse, and which should always be avoided, is shunting the responsibility for mistakes on to a subordinate with the remark: 'I am very sorry, but Mr. So-and-So made the mistake.' This is most disagreeable, and points to a lack of manliness.

"A chief draftsman should take the entire responsibility of the work passing through the office, should take the blame of any mistake upon himself, and not endeavor to shunt any blame on to the shoulders of a subordinate. This should not prevent him at the same time from passing on the remarks of the principal, with a few additional ones of his own, in order that the same mistake may not occur again. Be punctual yourself and insist upon absolute punctuality in your subordinates. When several pieces of work appear equally important, and it is a question in your mind which to tackle first in the morning, choose the one you like least, and this once finished, the others will go down before you like corn to the scythe of the reaper; this is a golden rule imparted to me by my late brother, which by long experience I have found invaluable. You will find it a useful thing to keep an agenda or question book and go over it every day yourself, also if possible with your superior, noting his instructions. I think I should refer you at this point to a paper I read early this year before the Institution of Engineers and Ship-builders in Scotland, entitled the 'Drawing-office,' in which you will find, I believe, many useful hints as to organization, should you be called to the position of chief draftsman.

"Suppose, now, that you go a step higher and become manager, your responsibility is further increased, and you have now a new set of conditions to deal with. You should still more closely, if possible, link up your principals' interests with your own. The most serious part of your duty will be in maintaining discipline in the works. Man in general is a most complicated machine to deal with, and the workingman is perhaps the most complicated machine of the human species. In most machines, given a certain set of conditions, you can predict what will happen when the machine works, but often with the human machine exactly the reverse happens to what you might have expected. No minute rules can be, therefore, laid down for the management of men, but you will go a long way toward success if, following out the treatment of your men in the drawing-office, you deal with the men in the works in a firm but pleasant way. Be definite in the orders you give, and see that they are promptly and cheerfully carried out. Do not be unreasonable in your demands, and in all your dealings with the men and the arrangements you make with them, be perfectly honest and straightforward, trying if possible to put yourself in their place. If you have profited by your time at the bench, you will not find this very hard to do. Where necessary, make written notes of any arrangements as to wages, etc., immediately they are made, read them to the men, sign them yourself, and get them to countersign. Leave nothing ambiguous, nothing doubtful, and if possible deal directly with the men, and not with paid agents. You will find under these circumstances that with few exceptions the workingman is to be trusted and admired. You must not suppose from what I have said about paid agents that I object to Trades Unions, but I do object to paid agents interfering at every moment, and with every petty question between master and man. I think that the men are quite able to discuss any detail at a meeting with the manager or master, and that an amicable arrangement is more likely to result from this course than when an outsider is called in to discuss the matter, who has no real personal interest in the works.

"You will find it advantageous to spend an hour in the factory before breakfast. An hour thus spent is worth two later in the day, when it may be difficult to spare the time, pressed as you probably will be by other business, visitors, outside contractors, etc., besides which it allows the foremen to get their instructions for the day, and you have a clearer mind, and are undisturbed by the thought that you are wanted elsewhere. Another reason is that any slackness and waste of time on the foremen's or workmen's part is more likely to occur then than later in the day. Never force a man upon an unwilling foreman. You are often asked, mostly by soft-hearted clergymen, to give some poor weak soul a chance. As a rule, resist the appeal; there are and should be exceptions. But as a rule you will find it labor wasted. Remember the cripples. There are always a dozen or so of easy berths which should be kept either for the old or maimed, and, even if an able-bodied man gets employment in them, he should at once be removed if a cripple comes along. Of course I mean your own cripples; don't saddle yourself with other people's.

"An important question is the amount of interference you should allow yourself between foremen and workmen. Theoretically there should be none, practically it should be the minimum possible, otherwise your time will be entirely taken up in perpetually listening to two sides of stupid differences. At the same time you should reserve the absolute power of dismissal or employment, always, however, through the foreman, and further, your ear should be open to any well-founded complaint of injustice on the part of a foreman to a man. If you are careful in the first two or three cases to dispense absolute justice, you will be little troubled later, because both foremen and men will be watchful of what they do. Keep in view the possibility of nepotism in foremen, and you must be quick to stamp it out; it is most detrimental to discipline. In both these cases you will observe that to manage properly you must have an intimate knowledge of your men. In a case of any man doing a piece of meritorious work, you will find it a good thing to take personal notice of it; it is the right thing to do, and encourages the man. I have often seen cases where a kind word, some tobacco or a few cigars given on the spur of the moment, have been more appreciated than a money gift.

"You should take a personal interest in your apprentices, they are your future workmen, encourage them to continue their education in every way possible at evening classes; the better educated they are, and the more they are on a par with yourself, the more easy it is to get on with men.

"The next step in the ladder is when you become a principal or partner in a business, and now your burden is greatly increased. You no longer work, in all likelihood, for a salary, and you have therefore all the care and anxiety of making sure of your livelihood. But you have a high duty also to all those under you, and you should take an interest in them not only in the works, but outside of the works; not a patronizing interest, not a mere subscribing to their schemes, their football clubs, cricket clubs, etc., but take an active interest in their pleasures and in their sorrows, and in doing so you will not only lighten their cares, but you will also have your own cares lightened by their sympathy and human interest. Above all, avoid trying ill-considered socialistic experiments, which to be successful assume that workingmen are all angels; they are no more angels than you are, and such schemes are failures before they are tried; only benefit schemes on a sound financial and co-operative principle will succeed—I mean those which are just to both parties.

"I may mention two schemes which have proved successful in my own experience—viz., an accident fund, managed by a committee, appointed in equal numbers by both master and men, and to the funds of which equal contributions are made; and also an awards scheme, by which men are rewarded who either invent new methods or machines, or introduce any scheme by which production is cheapened.

"Should you unfortunately after all your efforts be confronted by a prospective strike, consider well the situation, make up your mind what, under the worst circumstances, you would be induced to accede to, and having done so, say a final

yea or nay. Do not be readily induced to begin a strike and then give in; vacillation of this kind has been the leading cause of strikes. If the men realize that when you say yes you mean yes, and no, no, strikes will not readily occur, and you will notice that the modern tactics are all tending toward avoiding strikes, if at all possible. The men always lose by them and also the masters, for even if success crown the efforts of either party, the gain is never sufficient to make up for the individual loss.

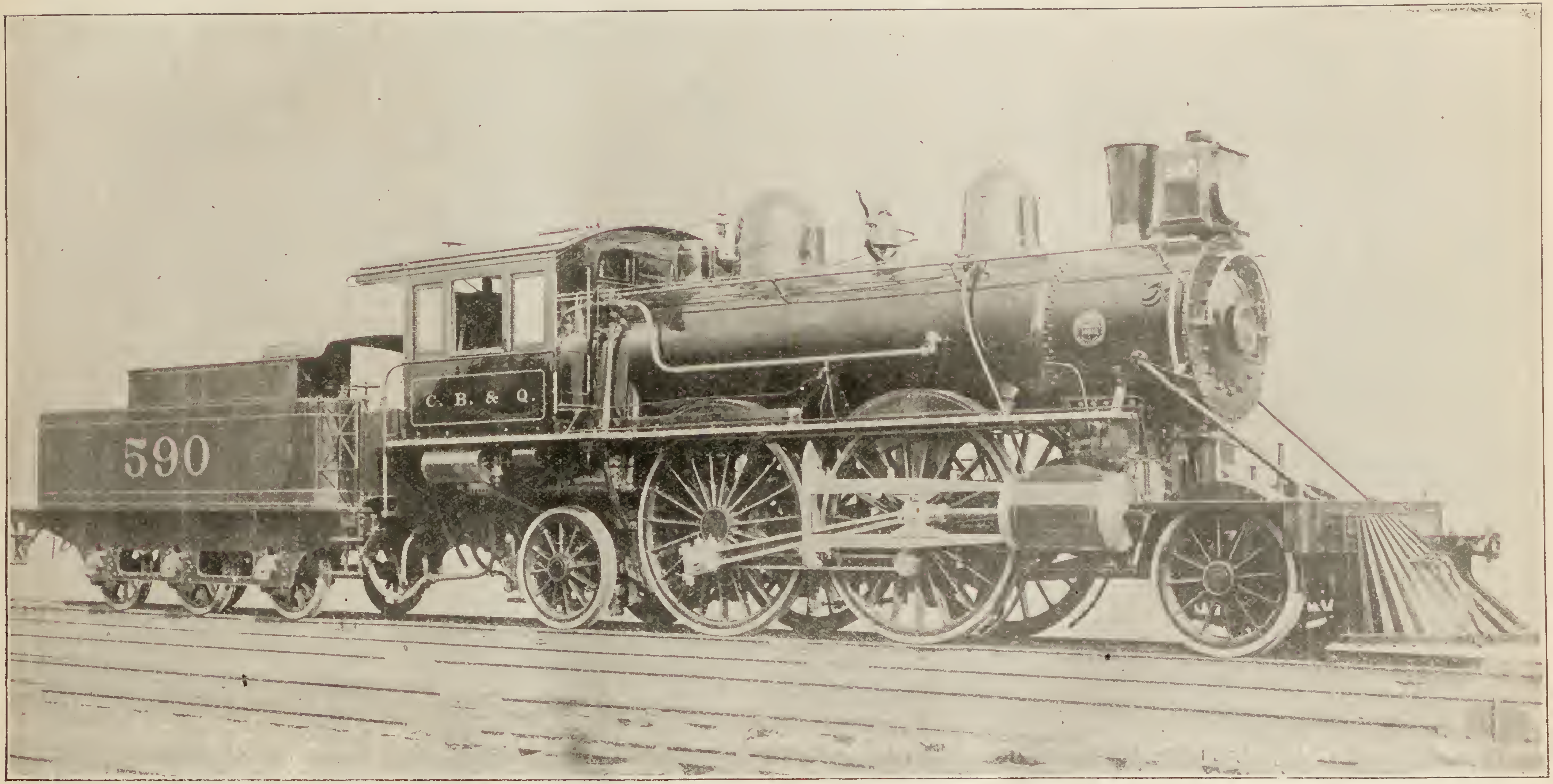
"I happened to read recently a paper by an American—Mr. Fred. W. Taylor—read before the American Society of Mechanical Engineers. In his paper there are a few sentences which so thoroughly express my own views, that I am sure Mr. Taylor will not object to my extracting them for you. He says, 'No system of management, however good, should be applied in a wooden way. The proper personal relations should always be maintained between the employers and men, and even the prejudices of the workmen should be considered in dealing with them. The employer who goes through his works with his kid gloves on, and is never known to dirty his hands or clothes, and who either talks to his men in a condescending or patronizing way, or else not at all, has no chance whatever of ascertaining their real thoughts or feelings. . . . Above all it is desirable that men should be talked to on their own level by those who are over them. Each man should be encouraged to discuss any trouble which he may have, either in the works or outside, with those over him. Men would far rather even be blamed by their bosses, especially if the 'tearing out' has a touch of human nature and feeling in it, than to be passed day by day without a word, and with no more notice than if they were part of the machinery. . . . The opportunity which each man should have of airing his mind freely, and having it out with his employers, is a safety valve; and if the superintendents are reasonable men, and listen to and treat with respect what their men have to say, there is absolutely no reason for labor unions and strikes. . . . It is not the large charities—however generous they may be—that are needed or appreciated by workmen, such as the founding of libraries and starting workingmen's clubs, so much as small acts of personal kindness and sympathy, which establish a bond of friendly feeling between them and their employers.' These sentiments have been the ruling factor in my firm since we began business, now fifty years ago, and when I tell you that no strike has occurred in our works since the year 1877, you may take it as a proof that our system of management, working on these lines, has not been unsuccessful.

"To be a successful business man requires a combination of qualities. It requires at the very beginning a certain knowledge of business methods and means, and none, perhaps, is so important as to understand the system of costing and cost keeping. This is too large a subject for me to enter into fully; there is only one point which is of such primary importance that I wish to deal with it in some detail. I refer to the question of charges—standing charges, as they are sometimes called. These charges vary in various businesses and in various localities. Roughly they may be classified under the following heads: (1) Conveyance; (2) coals; (3) stationery and printing; (4) gas and lighting; (5) repairs on buildings; (6) repairs on plant; (7) general upkeep and repairs; (8) naphtha, waste, oil, etc.; (9) stamps and telegrams; (10) water; (11) taxes and rent; (12) fire and boiler insurances; (13) salaries administrative; (14) salaries technical; (15) salaries commercial; (16) travelling expenses; (17) upkeep of contracts; (18) cleaning offices and sundry; (19) extra charges; (20) legal expenses; (21) depreciation. Different men consider different items as fixed charges, but the list I have given you is not an uncommon one.

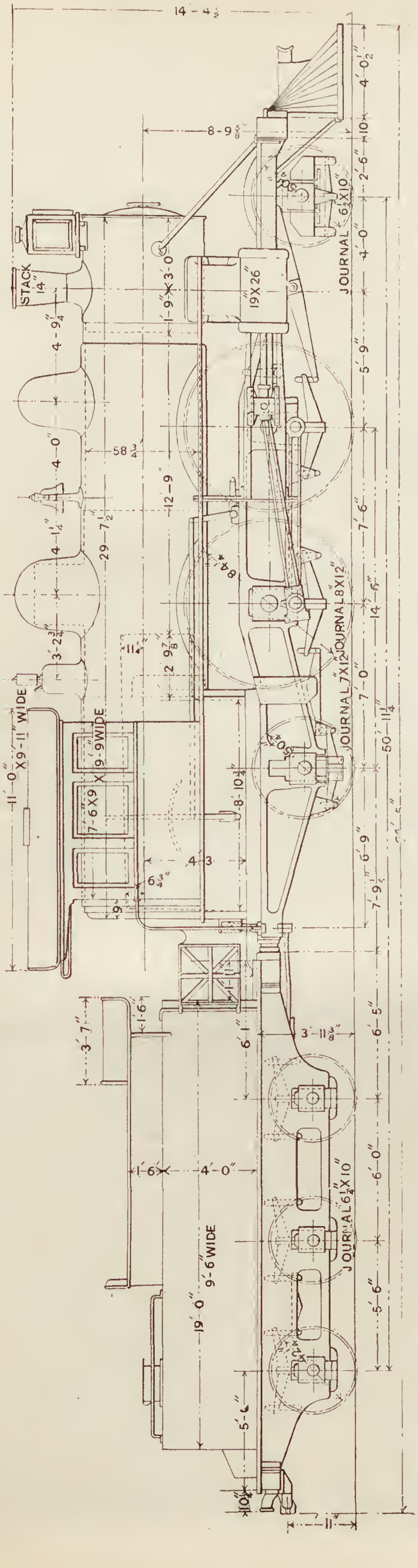
"The following explanatory remarks may be useful: (1) Conveyance: This is for carriage of material to and from the works. Of course, most supplies are bought carriage paid; some cannot be treated in this way, and in dispatching goods the expenses must be met. (2) Coal: This is one of the items which bulks largely in most businesses, and should be carefully watched. The quality of coals is one of the principal items, and carelessness on this head will soon run up a heavy bill. In a large business you will find it pay to have one man devote a large proportion of his time to watching this item alone. (3) Stationery and printing is an item apt to grow, and one in which the staff, more than the principal, can exercise economy. (4) Gas: You will find it useful to read your metre or metres every week; large leaks are likely to occur, which can only be checked in this way. (5 and 6) Repairs on building and repairs on plant are largely dependent upon the skill and care of the manager. (7) General upkeep and repairs: These items, which belong to neither of the other two, consist in small jobbing accounts which can grow if not watched. (8) Naphtha, waste, oil, etc.: It is better to have these separate item in charges, rather than to attempt dividing them over each job. (9) Stamps and telegrams: The telegram bill must be watched. (10) Water: The same remark applies to this as to gas. (11) Taxes and rent are largely uncontrollable. (12) Fire and boiler insurances: Too much economy in this may lead to disaster in the event of an accident. (13) Salaries administrative: That is, those paid to manager, under-managers, etc. (14) Technical salaries: Those paid to drawing-office staff. (15) Commercial: Those paid to the counting-house staff. I shall deal with these two latter items more fully immediately. (16) Travelling expenses: The travelling expenses of the staff when for any definite job should be carried directly to that job. These carried to charges should be those only of the principal and manager, which are often incurred in looking for work which is not secured, or general travelling. (17) Upkeep of contracts: There is a good deal of chance and luck affecting this item. Of course, careful work in the first instance reduces it to a minimum, but it is frequently advisable in large risks to cover by insurance. (18) Cleaning of offices, etc., explains itself. (19) Extra charges, viz., those items which cannot be charged to any more definite account, such as special bonuses to employés or outsiders. (20) Legal expenses: I can only express the hope that this may be a small item, and advise you to avoid law even at the sacrifice of what you may consider strict justice in some cases. It is an old saying that the only man more to be pitied than the loser in a law case is the winner. (21) Depreciation: This is a most serious item, and one which cannot well be too large. If the partners in a business are of greatly different ages, it is to the advantage of the younger member and to the disadvantage of the older that this item should be large. The legal depreciation allowed by the income tax authorities is too small. Good practice is to take 10 per cent. off the original cost of all tools year by year until they are virtually written down to scrap price. If your business is to succeed, you must be continually adding new machines, and as it is not advisable to go on increasing your capital indefinitely, therefore your power of purchasing new machines must be largely derived from the depreciation of those you already have. If your buildings are substantial, 2½ per cent. may be enough provided that in both cases you upkeep your buildings and tools from revenue. Depreciation should be the first consideration, and division of profits should only come in after the depreciation account has been fully satisfied.

"In most businesses it is usual to find out by years of experience what roughly is the percentage these charges bear from year to year to the wages bill. The wages bill is chosen because it is less fluctuating than materials, and because it is some measure of your power of output—I mean how much work you can turn out. I will not go into detail for many reasons, but roughly, and as a guide to you, if you are ever called upon to decide this question, in ship-building, if you find these charges exceeding 30 per cent. it is time to carefully consider the position of affairs, and if you find them falling below 20 per cent. it is also time to look carefully into matters, and for this reason. One of the largest items under charges is salaries of draftsmen, clerks, managers, etc. Now you can either have this item too large or too small. If it is too small there will be insufficient supervision or insufficient plans; this will increase the total expense of working, the wages will rise, and apparently your charges will fall in percentage. On the other hand, it is quite clear, if the staff is too large, this leads directly to large charges, with probably a moderate wages bill. Staff should therefore be only pushed to such a point that the wages are kept a minimum by careful supervision; beyond this, increase of staff is a questionable advantage. I am not so cognizant of what charges should be in a marine engine works, but from what I can learn you would require to study the position of affairs should they exceed 30 per cent. of the wages. I do not lay these down as fixed limits; charges largely depend upon the size of the business, the amount of turnover, and I have been considering medium sized concerns, but they will be some guide to you starting with probably little experience.

"My final advice to you is to make your work your first business, but do not allow it to entirely absorb your attention; you should have some harmless hobby or amusement to which you can turn your attention when the day's business is done; you should not always carry your business on your shoulder like the 'old man of the sea.' In business be careful of the small things; they are sometimes more important than the larger issues. While pushing forward with all the energy you possess, be thoughtful for and careful of others less favored than yourself; and finally, while I am not enamored of Latin, I would like to sum up the matter in two words often used to me by one of my best friends, and excellent advice it is for young men—*Festina lente.*"



EXPRESS PASSENGER LOCOMOTIVE FOR THE CHICAGO, BURLINGTON & QUINCY RAILROAD, EUILT BY THE BALDWIN LOCOMOTIVE WORKS.



OUTLINE OF AN EXPRESS PASSENGER LOCOMOTIVE BUILT FOR THE CHICAGO, BURLINGTON & QUINCY RAILROAD BY THE BALDWIN LOCOMOTIVE WORKS.

NEW EXPRESS PASSENGER LOCOMOTIVE FOR THE CHICAGO, BURLINGTON & QUINCY RAILROAD.

The two engravings which we give with this number represent a new express locomotive ordered some time ago by Mr. Godfrey Rhodes, the Superintendent of Motive Power of the Chicago, Burlington & Quincy Line, of the Baldwin Locomotive Works. It will be remembered by some of our readers that in the June number of the American Engineer there was published an illustration of an engine of this general type, but with a four-wheeled leading truck. This engine was built for the Concord & Montreal Railroad. In our issue for July we published engravings of an ordinary American type of locomotive, built by the Schenectady Company for the same road and for the same service. This being the case, notwithstanding the fact that comparisons are odious, there will be an inquiry as to which of the two classes of engines are best adapted to the service in which they are employed. Up to the present time we have no data bearing on this point. In the number of the paper, however, in which the Schenectady engine was illustrated, we ventured to comment on the two engines, and in the article containing these comments it was said :

" The writer confesses to a predilection for a design of locomotive similar to that which the Baldwin Works have adopted. A concession, however, had to be made by them to the impression that a four-wheeled leading truck is essential for safety in a high-speed engine. This makes it difficult to get all the advantages which would result from this general plan if it was somewhat modified. It will be remembered that the *Columbia*, which the Baldwin Company exhibited at Chicago, had a leading truck with a single pair of wheels in front. With this arrangement and by moving the driving-wheels about a foot farther forward, the fire-box would be entirely behind the back pair. If a pair of trailing wheels of 36 in. in diameter were substituted instead of the 50-in. wheels which were used, the fire-box could then be made as wide as might be desired, and therefore shorter than it was in the engine for the Concord Road.

" We have quoted a number of times in these pages a paper written about two or more years ago by Frederick Siemens, in which he showed that whenever flame came in contact with any solid substance combustion was partially arrested, and that in all furnaces we should aim to keep the flame out of contact with their sides until the process of combustion is completed. The inference from this was that a sphere would be the ideal form for a furnace, and in fact that is approximately the shape adopted in the ordinary egg-shaped stoves for burning bituminous coal. But as a sphere would not be a convenient form for a locomotive fire-box, and as a cube is the closest approximation thereto that existing shapes will admit of, the inference is that it might be well to make locomotive furnaces of such dimensions that their height, length and breadth would all be equal. This would be possible with a locomotive of a design similar to the *Columbia*, and it is believed would make a very efficient engine. The plan permits the driving-wheels to be placed as close together as the flanges of their wheels will allow. The coupling-rods may therefore be correspondingly shortened. These wheels being under the middle of the engine, they can be loaded with as much or as little weight as may be desired, and a liberal length of tube would be provided."

From the quotation and our illustrations it will be seen that Mr. Rhodes and the Baldwin Locomotive Works have embodied the suggestions which were made last July in the engine which has recently been put in service on the Chicago, Burlington & Quincy Road, and which is illustrated herewith. Now, it is not intended to intimate that the peculiar features of this machine were adopted because they were suggested in these pages, as Mr. Rhodes, and doubtless the engineers of the great Philadelphia engine works, had probably long before that evolved out of their inner consciousnesses the same inferences that we did ; but as the engine before us embodies these features, it will be very interesting to know how near she comes to fulfilling the predictions which we ventured to make. This is written with a full consciousness of the danger of submitting prophecies to the actual test of fulfilment, but this was assumed when the predictions were made, and Mr. Rhodes' experience will indicate whether there has been any false predictions. It should be said that Mr. Rhodes has for a number of years been hauling heavy express trains with mogul engines, and no longer entertains the superstition which is so common among railroad men in this country of thinking that it is not safe to run a locomotive at high speed with a single axle truck leading, and has, therefore, had this feature adopted in the engine under consideration, of which the following is the

SPECIFICATION.

Cylinders, 19 in. in diameter and 26 in. stroke; driving-wheels, 84¼ in. in diameter; gauge, 4 ft. 8½ in.; fuel, soft coal; total wheel-base, 24 ft. 3 in.; driving-wheel-base, 7 ft. 6 in; rigid wheel-base, 14 ft. 6 in.*; total wheel-base of locomotive and tender not to exceed 51 ft. 0 in.; weight in working order, total about 135,000 lbs.; on driving-wheels, about 84,000 lbs.; weight of tender, with fuel and water, about 90,000 lbs; weight on trailing wheels, 33,000 lbs.; limits of height 14 ft. 6 in.

The boiler is of the straight-top type with radial stays for the crown sheet, and it is made throughout of flange plates of homogeneous cast steel $\frac{11}{16}$ in. thick; all of the longitudinal seams are butt jointed with double covering strips caulked inside and outside. The throat sheet is $\frac{1}{8}$ in. thicker than the shell of the boiler to prevent undue thinning where flanged. The working pressure is 200 lbs.

The waist of the boiler is 58¾ in. in diameter at the smoke-box end, and 57⅝ in. at the inside diameter of the smallest ring. The dome has an outside diameter of 2 ft. 8½ in. and a height of 2 ft.; it is located centrally. The dome ring is of pressed steel 1 in. thick. The tubes are of iron of No. 11 B. W. G. thick, with copper ferrules on swaged ends in the fire box tube-sheet. They are 210 in number and 2 in. in diameter, 12 ft. 9 in. long.

The fire-box is 8 ft. 10¾ in. long by 5 ft. wide on the inside, 5 ft. 2¼ in. deep at the front and 4 ft. 9¾ in. deep at the back, and is made of homogeneous cast steel which was annealed after flanging; side and back sheets, $\frac{5}{16}$ in. thick; crown sheet and tube sheet, ½ in. thick; flue sheet, ½ in. thick; water space, 4 in. sides and back, 4 in. front; stay-bolts of iron, 1 in. in diameter, screwed and riveted to sheet, and not over 4 in. from centre to centre; fire-door opening formed by flanging and riveting together the inner and outer sheets; tool-guard to be cast on lower part of fire-door frame; fire-brick arch in combustion chamber.

Crown stayed by radial stay-bolts 1⅛ in. in diameter, not over 4 in. from centre to centre, screwed through crown sheet and roof of boiler, and riveted over. The heating surface of the fire-box is 187.4 sq. ft.; of the tubes, 1,392.72 sq. ft., giving a total of 1580.12 sq. ft. Dry steam pipe inside boiler of wrought iron. Steam pipes in smoke-box, cast iron. Cleaning plugs in corners of fire-box. Balanced puppet throttle valve of cast iron, in vertical arm of dry pipe.

Grates, rocking and drop, and have an area of 44 27 sq. ft. Ash-pan, with front damper, slides in bottom.

Smoke-stack straight.

Smoke box, extended, with netting, deflecting-plate and spark hopper.

Frames of steel, made in two sections, and spaced 3 ft. 7 in. from centre to centre. Front rails bolted and keyed to main frames, and with front and back lugs forged on for cylinder connections. The bumper beams on the engine are 9 ft. 9 in. long. Pedestals forged solid with main frames and protected from wear of boxes by cast-iron gibs and wedges. Pedestal cap lugged and bolted to bottom of pedestals.

The trailing wheels are 4 ft. 2¼ in. in diameter with steel tires held by shrinkage and retaining rings to cast-steel centres. The journals of the axles are 7 in. × 12 in. At the front there is a centre-bearing swivelling two wheeled truck with a radius bar. The truck frame is of wrought iron, with braces of wrought-iron fitted with a swinging bolster. The two steel-tired wheels with cast-steel centres are 4 ft. 2¼ in. in diameter. The axle is of hammered steel, with journals 6½ in. in diameter, and 10 in. long.

The springs are of crucible steel tempered in oil, and are connected by equalizing beams resting on the top of the boxes.

The cylinders are spaced 7 ft. 1 in. transversely from centre to centre, and each is cast in one piece with a half saddle placed horizontally, the right and left-hand cylinders being reversible and interchangeable. The cylinders and air pump are oiled by a Nathan triple automatic sight-feed lubricator placed in the cab and connected to the steam-chest by copper pipes running under the jacket. These pipes are proved to a pressure of 200 lbs. The steam pipes have a sectional area of 25.9 sq. in., and the valves are of the piston type with a maximum travel of 6 in. The lead is $\frac{1}{32}$ in. in full gear and the lap 1 in. The pistons are of cast iron with an approved form of packing, and have a clearance of ¼ in. at each end. Jerome metallic packing is used for the piston-rods and valve stems.

The guides are of steel fitted to a wrought-iron guide yoke. The crossheads are of cast steel.

* One quarter in. extra play on trailing wheels.

The shifting valve motion is used with links having a radius of 5 ft. 2 in.

The main valves are of the piston type, 10 in. in diameter.

The driving-wheels are 84¼ in. in diameter, and their centres are of cast steel turned to a diameter of 78 in. The tires are held by shrinkage and retaining rings; they are of cast steel 3⅛ in. thick when finished. Both pairs are flanged and are 5½ in. wide.

The axles are of hammered steel with journals 8½ in. in diameter and 12 in. long. The driving-boxes are of steeled cast iron with brass bearings.

The connecting and coupling-rods are of open-hearth steel. The crank-pins are of steel, the main pins being 6 in. in diameter and 6 in. long, the wrist-pin being 3½ in. in diameter and 3 in. long. The front side-rod pin is 5½ in. in diameter and 4 in. long, and the back pin is 6½ in. in diameter and 4½ in. long.

The feed water is supplied by one 9½ in. and one 10½ in. Sellers injector.

Engine to be furnished with one sand-box and Leach sander, stand for head lamp, bell, West bell-ringer with self-acting lubricator, whistle, blow-off cock, blower and two 3-in. Richardson sealed safety valves, two steam-gauges, cab-lamp, gauge-cocks; also a complete set of tools, consisting of two heavy jack-screws and levers, one heavy pinch-bar with steel point and heel, complete set of wrenches to fit all nuts and bolts on engine, including two monkey-wrenches, one set of driving box packing tools, one machinist's hammer, one soft hammer, three cold chisels (two flat and one cape), one long-spout quart oil-can, one two-gallon oil-can, one tallow-pot, one torch, engineer's arm-rest, one extra fusible plug, one bell-cord, cab-seats, cab-seat cushions, one poker, one scraper, one slice-bar, and one scoop shovel, headlight with 22½-in. reflector, two water gauges and lamps, Westinghouse-American outside equalized brake on driving, trailing and tender wheels, 9½-in. pump, and train signal.

Six-wheeled tender. Tank of steel or iron, strongly put together with angle-iron corners, and well braced. Top, inside and bottom plates, ¼ in. thick; outside plates, $\frac{3}{16}$ in. thick; riveted with $\frac{7}{16}$ in. rivets, not over 1 in. and 2 in. pitch. Capacity, 4,000 galls. (of 231 cub. in). Shape of tank, U. Roof over tender. Tender frame substantially built of steel strongly braced. Six wheels working in pedestals. Wrought-iron centre steel tired wheels, 42½ in. in diameter. Brakes on both trucks. Axles of steel; outside journals, 6¼ in. in diameter and 10 in. long. Oil tight boxes and brass bearings. The Janney coupler is used at the rear.

The total weight of the engine in working order is 138,000 lbs., of which 39,600 lbs. is on the front drivers, 46,600 lbs. on the main drivers, giving a total of 86,200 lbs. in all. The trailers carry 31,800 lbs. and the front truck 20,000 lbs.

SHOP NOTES.

At the meeting of the Western Railroad Club, held on November 19, Mr. Bell's paper on Wide Fire-boxes was discussed. Mr. Rhodes, of the Chicago, Burlington & Quincy Railroad, gave the experience which he had on that line with two engines having Wootten fire-boxes. With screened coal—such as was used in other locomotives—these engines failed to steam when pushed, owing to the formation of holes in the fire-bed, through which the air was drawn; but when fired with slack coal and screenings such as the other engines could not use, the Wootten boilers were excellent steamers. After a protracted trial on the road, this class of boiler was condemned, not as above stated on account of bad steaming, but because they had no supply of the kind of fuel which these boilers were adapted for, and also on account of the large amount of boiler repairs which they required compared with other engines. On that account he characterized them as "shop engines" and not as "road engines." He attributed this unsatisfactory boiler service to the character of the water found on the line of their line, and he had every reason to believe that they would have been entirely satisfactory using the water found on Eastern railroads, where they originated and are still in successful operation.

Mr. Forsyth and Mr. Gibbs were of the opinion that the best results were obtained with locomotive boilers when from 100 lbs. to 125 lbs. of coal were consumed per square foot of grate per hour.

In a discussion on freight-car doors, Mr. Waitt considered that all side doors should be hung from the top, as several accidents had occurred on his road by doors becoming detached while passing other trains. Such doors were dependent upon a rabbet to hold them in place at the top.

CHICAGO, ROCK ISLAND & PACIFIC RAILROAD SHOPS.

Mr. Wilson Superintendent of Machinery of the Chicago, Rock Island & Pacific Railroad, is, so far as we are aware, making more use of compressed air in his shops than any other person occupying a similar position, although Mr. Player, of the Atchison, Topeka & Santa Fé Road, and Mr. McConnell, of the Union Pacific, have the reputation of using compressed air whenever it is possible. Mr. Wilson's compressor, which is used at the Chicago shops, was built by Edward P. Allis & Co., of Milwaukee, and is operated by the stationary engine which drives the shop shafting. The piston-rod of the air-pump is attached to the piston of the engine, which has a stroke of 42 in. The air cylinder is 12 in. in diameter, and the valves are of the Corliss type. When the maximum pressure of 105 lbs per square inch is reached, a further increase of air pressure is prevented by an automatic valve, which allows the air to escape from the cylinder before it enters the distributing mains, which are altogether about four miles in length. In the erecting and machine shop there are 26 air lifts of various kinds and sizes for handling everything heavy that must be machined or moved from place to place. In the various shops there are about twenty air-driven engines of different types and for various purposes—from three-cylinder engines for driving flexible shafting to small breast drills. In addition to these there are many special tools also air-driven, such as the Baird stay-bolt breaker, stay-bolt cutters and foundation-ring miller, a machine for bending to standard shape the 3-in. brick arch circulating pipes, a metal stamp in the tin shop, a device for holding brasses when they are being lined with lead, a punch for cutting rubber gaskets, etc.

The compressed air is conducted to the car repair yard, about half a mile from the compressor. Here it is used for boring holes in timber, for operating a drop pit for changing wheels as well as for testing air brakes. A number of reservoirs are located at different points in the shops for storing up the required amount of compressed air. These are made of the cylindrical portion or waists of old boilers, and are of various sizes up to 12 ft. in length. Compressed air is used for charging the boilers of repaired engines, so as to enable them to move themselves from the erecting shop into the round-house.

The result of using compressed air for operating special tools in the boiler shop is that the labor required to remove and replace a 6 ft. fire-box has been reduced to about $180.

In the smith shop an unusual amount of work is done with the "bulldozer." There are three bolt headers of the company's make, one taking in 2¼-in. iron. There are three Bradley 200-lb. hammers, one 2,500-lb. hammer, one 1,500 lb. steam hammer, one 1,200 lb., one 1,000 lb. and one 800 lb. At the present time there are only 12 fires in operation, the majority of the work being done in heating furnaces in conjunction with the above-mentioned hammers. Oil is about to be introduced as fuel for these furnaces.

An excellent time-saving device for heating tires is operated by carbureted air. Ordinary gasoline, such as is used in cooking stoves, is brought into contact with a jet of air, which forms the gas used. The time required to remove a tire depends upon its thickness, and varies from 8 to 20 minutes.

At the Chicago shops, Mr. J. W. Fitzgibbon, Master Mechanic of the Illinois division, takes care of 150 engines, and does all the cylinder and crank-pin work for the whole system as well as the renewals of fire-boxes. The standard eight-wheeled passenger engines have 18 × 24-in. cylinders and 5 ft. 9 in. wheels. The heavy passenger engines are 10-wheelers with 19½ × 24-in. cylinders and 5 ft. 9 in. wheels. To handle faster trains, Mr. Wilson is about to design a still more powerful class of engine. A steam pressure of 170 lbs. is carried on all new passenger engines. Particular attention is paid to boiler and stay-bolt inspection.

CHICAGO & NORTHWESTERN RAILROAD SHOPS.

In the Chicago shops of this company the men are now working nine hours.

Since Mr. Quayle took charge of the motive power department of this road he has turned most of his energy in the direction of fuel-saving. As the annual amount of the coal bill is about $3,000,000, it can be readily seen that even a saving of 1 per cent. will be worthy of an effort

By means of a circular letter issued in February last, and addressed to the engineers and firemen, Mr. Quayle called their attention to the "great importance of using the coal burned on the locomotives of the company with the utmost care and good judgment, in order that every pound be utilized to the best advantage." He stated that there were engineers in the service who were costing the company upward of $1,000 per year more for coal burned on the engines run by them than other engineers running the same kind of engine in the same kind of service. Mr. Quayle, after speaking of the necessity for the existence of the very best of feeling among the officers and men, and between the engineer and fireman on the same engine, in general terms describes the duties of the engineers and firemen and the ways in which fuel can be saved or wasted by either one of them.

By investigating individual cases he has been able, by changing men, to discover the man to blame for excessive coal consumption, and in some cases inculpating the engineer ; in others the fireman ; and sometimes the conductor, who by wasting time at stations, rendered fast running, and consequent waste of fuel, necessary.

Mr. Quayle has every reason to believe that the effect of his circular and investigations will be very satisfactory.

His company has recently received some heavy eight-wheeled passenger engines from the Schenectady Locomotive Works. One of them, when indicated recently at a speed of 72 miles per hour, developed 1,268 H P. These engines have 19 × 24-in. cylinders, 75-in. driving-wheels, 36-in. truck wheels, and carry 190 lbs. steam pressure. The front course of the boiler shell is 62 in. outside diameter, and the wagon top is 72 in. in diameter. In working order these engines have 81,450 lbs. upon the drivers and 45,950 lbs. upon the truck. The wheel centres are of cast steel, as are also the cross-heads, which are cored out, and made as light as possible. The main and side-rods are fluted, and weight in them has been reduced to the utmost.

Some engines on the road which have 20-in. ports and Allan Richardson valves have been giving trouble from excessive cutting of the valves and strips on the edge nearest the outside of steam-chests. Upon investigation, it was decided that the trouble was caused by want of proper lubrication on that part of the valve ; and to test the correctness of the theory, the lubricator pipes were disconnected from the centre of the steam-chest covers, and holes were tapped into the steam ports at the junction of the saddles with the cylinders of two engines. The experiment showed that Mr. Quayle's hypothesis was correct, as the trouble has disappeared, and the engines can be hooked up without any undue difficulty.

As these steam-ports, steam-chests, balance-plates and valves are not at variance in design to corresponding parts of other engines as generally designed, this experience would indicate that the centre of the steam-chest cover is not the best location for the delivery of oil from the lubricator, and that the trouble that was excessive in the case of these engines—owing, perhaps, to high steam pressure and large valves—exists more or less in all steam-chests, and should be looked into and the proper remedy applied

Mr. Quayle has installed in one of the round-houses an engine-testing device of the same character as that used by him at Kakanna for blast-pipe and stack experiments, only of a permanent and more useful nature than the original. It is arranged with three pairs of carrying wheels, the centres of all which being adjustable, enables him to test any build of four or six-wheel coupled locomotive. The latest addition to this plant is the use of a governor for regulating the pull on the friction-brake and speed of the engine wheels. Its use has enabled him to control the speed within one-quarter mile per hour, showing a straight line on the Boyes speed recorder used in connection with the tests.

In the smith's shop an axle furnace is kept running day and night on car axles—a large proportion of the axles used, not only for repairs but also for new cars, being made by the company. Crank-pins and piston-rods are also made from selected scrap in these shops In fitting piston-rods into cross heads no shoulder is left on rods, but the taper is allowed to run out outside the cross head ; and Mr. Quayle has introduced the good plan of making the large diameter of the fit of a greater diameter than the body of the rod ; and, following in the same line, is making the wheel fit of his engine axles considerably larger than the journals, thus getting over the tendency to break at the face of or inside the hubs of the wheels. Of course this is nothing new in locomotive design it being the regular practice in England and the continent of Europe, but is a departure from the deep rut that has been followed for economical construction purposes in this country.

A new departure in lathe tools is likely to follow the experiment of using a small section of tool steel mounted in a carrier or holder of a cheaper material, thus reducing the stock of high-priced tool steel to a minimum. Messrs. Pratt & Whitney have, we believe, followed and advocated this system for many years.

ILLINOIS CENTRAL RAILROAD SHOPS.

One of the novel appliances in these shops is the filling of

oil cans from the storage tanks in the cellar by air pressure. Instead of applying the air pressure directly to the large tanks, it is applied to the upper end of a closed pipe about 8 in. in diameter, the lower end of which is connected by a pipe and check-valve with the bottom of tank. This stand-pipe is the same height as the tank to which it is connected. By opening a valve and releasing the air pressure upon the top of the oil in this pipe, the check valve opens and allows the oil in the tank to fill the pipe to the same level as it is in the tank. When an oil-can is to be filled, the release valve is closed and the pressure valve opened, admitting air upon the surface of the oil in the pipe, closing the check-valve and forcing the oil to a cock, from which it is drawn. By this means very little air is used each time it is turned on to force the oil to the level from which the cans are filled. Each storage tank has its "stand-pipe" from which a quantity of oil can be drawn at any time by the process above described.

THE ATLANTA EXPOSITION.

The event of the year, if not of the decade, for the Southern States, is the Exposition now being held at Atlanta. It is peculiarly a Southern enterprise in which the whole South is interested and of which it is justly proud. Atlanta has borne the brunt of the burden and supplied the sinews of war with which the enterprise has been brought to a successful issue, while the whole country has contributed its quota of exhibits to attract the visitor and lend encouragement to the workers. In this last the railroads of Georgia have been particularly active, and well they might be, for anything which tends to stimulate industrial activity in the country through which they run, to induce immigration and to develop the latent resources, must most directly bear upon their own revenues. But whether it be from these motives or from those of an enthusiastic co-operation without the hope of gain, it is a fact that the two great systems, the "Plant" and the "Southern," that centre in Georgia have exhibits worthy of attention.

While the Southern has a fine exhibit upon the grounds, showing the resources of the country through which it passes, and to which a later reference will be made, a more interesting exhibit is to be found in the road itself as used by the visitor from the North on his way to and from the Exposition city. To any one who passed over the route as lately as three years ago, and then rides over it to-day, the change in the condition of affairs is most striking. At that time little could be said that would be complimentary to the motive power or the roadway. The engines were worn and sorely in need of repairs, and the track was one long call for new rails and sounder ties. At that time the schedules were comparatively slow and the cars hard to ride in. But new rails have been laid, fresh ties have taken the place of the old, the ballast has been brought up to surface, and broken stone is largely used; then, that the improvement may not be limited strictly to the essentials, the banks and slopes have been graded and smoothed, and, last, but by no means least, in the expense of maintenance and the preservation of the roadway, the ditches have been cleaned so that the drainage is what it should be. New engines and cars have been put in service, and for speed and accommodation the through expresses compare favorably with the best of other sections of the country.

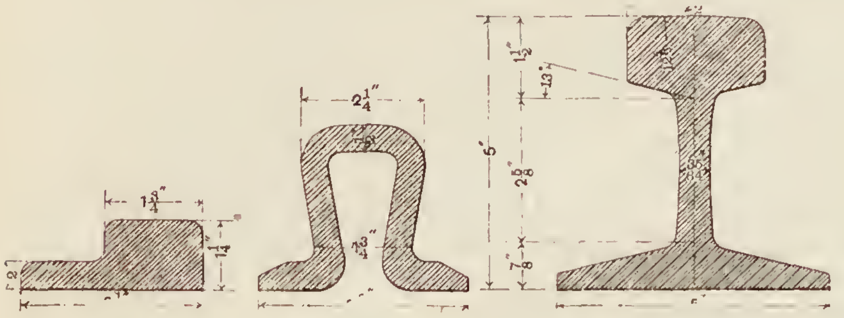
On the grounds of the Exposition the Southern Railway has a fine building in which samples of the products of the States through which the road runs are shown. There is coal from Virginia, Alabama and the Jellico district of Tennessee; and that the dusky diamonds may not claim the sole attention, there are genuine diamonds from North Carolina and rubies from the corundum quarries along the line. Iron ores are exhibited from Alabama, North Carolina, South Carolina, Georgia, Virginia and Tennessee, with some samples of copper, lead, zinc and gold. The agricultural resources are shown in the wheat, corn, oats, rye, timothy, flax, and, of course, the tobacco and cotton. Outside the building there is an interesting progressive study in track construction, of which we present the reproduction of a photograph. There are three short sections of track, illustrating the roadway of what is now the Southern Railway in 1855, 1864 and 1895. In the first the rail used resembled the tram rail now commonly used upon horse railways, but much lighter than any that we have seen for a number of years, and which has been entirely discarded for electric roads. This light rail, which weighed only 21½ lbs. to the yard, was laid with the tram outward upon stringers 7 in. deep and 6½ in. wide. These stringers rested upon two types of sleepers. Into the larger and heavier of the two (x) the stringer (y) was gained to a depth of 4 in., and was held firmly against the outer edge of the gain by a wedge, z, that tapered from 4 in. at one side of the tie to 2 in. at the other. These main sleepers or ties were spaced about 4 ft. 8 in. from centre to centre, and midway between them there was a smaller sleeper into which the stringers were not gained. The main ties were much the heavier, and averaged 10 in. × 10 in. No ballast was used above the bottom of the sleeper, and the imagination shudders at the weariness of a day's ride over this primitive track in the primitive cars of the time before the attention of car-builders had been directed toward the construction of a comfortable seat or the careful adjustment of the springs to the load that they would be called upon to carry.

TRACK EXHIBIT OF THE SOUTHERN RAILWAY COMPANY AT THE ATLANTA EXPOSITION.

The track of 1864 was laid with the old Barlow form of rail

that weighed about 42½ lbs. to the yard. It was spiked to ties, the stringers having been discarded and some improvements made in the disposition of the ballast. The surface of the latter rounded down from the top of the centre of the ties to the bottom of the ends. It was dirt, not gravel, and apparently was procured from the most convenient locality, regardless of its quality. The bed was heavy and poorly drained, and had it been subjected to Northern frosts, the irregularities that it would have shown when heaving set in would have rivalled the typical ram's horn in its tortuousness. The joints were made by wrought-iron chairs held by four spikes ; the rail itself being held by two at each tie, these latter being spaced 2 ft. 6 in. from centre to centre.

It would be interesting if we could have had a series of exhibits showing the gradual improvement in the roadway from 1864 down to 1895, when we find that the standard is well up

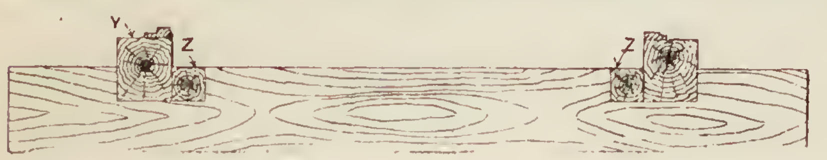


1855. 1864. 1895.

RAIL SECTIONS OF SOUTHERN RAILWAY TRACKS.

to the best of modern requirements. Broken stone ballast, ties with 10-in. face and spaced 2 ft. 4 in. from centre to centre, the Servis tie-plate on every tie, rails weighing 80 lbs. to the yard, angle-bar rail joints and first-class surfacing. Our readers know what this represents, and the accompanying engraving illustrates the three gradations of track with great distinctness.

The exhibit of locomotives and cars is an abridged edition of some of the exhibits at Chicago. The Pullman Company show a vestibule train that may be the identical one that attracted so much attention in 1893. The Plant system of railways also have a passenger train on exhibition, but neither of these present any striking features with which our readers are not already familiar. They are merely examples of the latest



SECTION OF 1855 TRACK OF SOUTHERN RAILWAY.

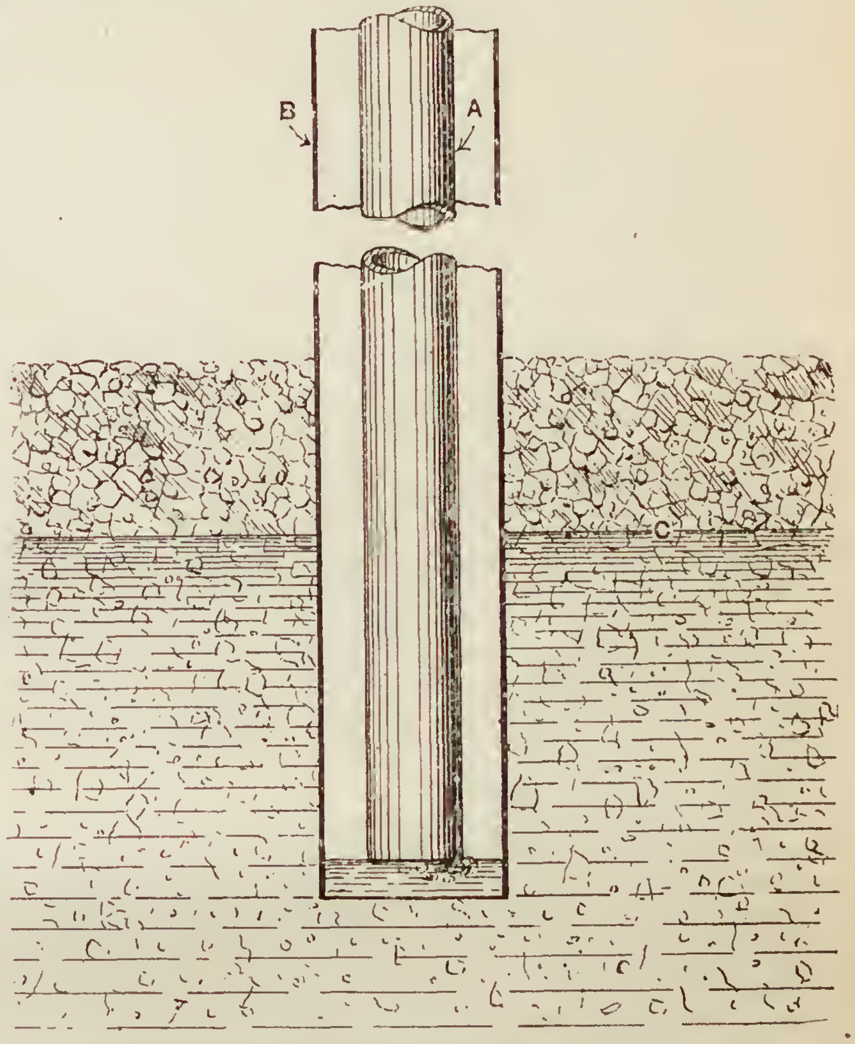
product of the best practice in passenger-car building. The exhibit of the Plant system also includes a model freight train built upon a scale of about one-half size, and representing the standard locomotive that is used, with the various types of flat, gondola, and box cars, with typical loads in miniature, and a plainly printed notice giving the tonnage of cotton, lumber, resin, coal and other products that have been handled by this road during the last fiscal year.

There are some fine examples of locomotives in the transportation shed. There is a compound built by the Baldwin Locomotive Works that is under steam and with drivers in motion. The Richmond Locomotive Works also exhibit a compound, and theirs is the one that has been undergoing a trial in service on so many roads and which has produced such satisfactory results. Each of these two firms also exhibit simple engines, and there is one of these by the Rogers Locomotive Company which has the peculiarity of having both injectors upon the right-hand side and delivering into a double check valve held by a single casing. One injector is inside the cab in the usual place, while the other is outside above the running board.

In Machinery Hall there is a fine exhibition of modern machinery of great variety. Probably the largest is the pumps that are at work supplying water for the fountains and other uses about the grounds. These are now delivering about 21,000,000 galls per day, and though only the larger sizes are at work, the exhibit includes everything down to the small feed pump that could readily be carried under the arm. One thing that lends attractiveness to the hall is the location of the shafting beneath the floor, where it is out of sight, and where it can be watched and oiled by the attendants without interruption or annoyance.

In this review it is merely possible to mention a few of the more striking machines, some of which will be illustrated in detail in future issues. The engines, of course, occupy a prominent place, and are nearly all engaged in driving the dynamos that furnish the light for the building and grounds. Among those to be seen are two fine Corliss engines built by Lane & Bodley and the Frick Company respectively, several Westinghouse engines, a tandem compound by the Harrisburg Foundry & Machine Works, and a vertical compound by the American Engine Company.

There is one exhibit illustrating the increasing range in the use of compressed air that is made in connection with the Bacon system of increasing the flow of artesian wells by the Knowles Steam Pump Works. The apparatus on the ground is pumping water from a cistern 50 ft. below the level of the floor. An air compressor supplies air at a pressure of 10 lbs. per square in., and the delivery is 250 galls. per minute. With a pressure of 35 lbs. per square inch, 100 galls. per minute can be raised from a well 250 ft. deep. The water is literally blown up, and in order to explain the operation we refer the reader to the accompanying diagram. *A* is the water pipe, and outside it the casing *B* is sunk so that the lower end of the latter is a trifle below that of the former. In the water-bearing strata the water level is supposed to stand at *C*, and it will have a constant tendency to rise about the bottoms of the pipes and enter them. The compressed air that is forced down



BACON COMPRESSED AIR SYSTEM OF PUMPING.

between the casing and the water pipe drives the water before it, and, as it turns at the bottom to enter the inner pipe, it catches the water at that point and carries it with it in its rush to the surface. The system has been extensively introduced in the South for increasing the flow of artesian wells.

Machine tools are sparingly exhibited, and nothing outside the range of standard stock machines are shown. There are some fine examples of wood-working machinery, but it is confined to planers and sanding machinery ; and nothing is presented in the way of a saw-mill equipment, as would be naturally expected at an exhibition held in a section where the lumber interests are still of such magnitude as they are in Georgia. As we have said, there are a number of fine exhibits of special machinery that have been left unmentioned in this review because illustrated descriptions of them will shortly appear in our columns.

We cannot close without one word of criticism on this and of suggestion to the promoters of future expositions of this class. The first impression, even at this late day, that the visitor has upon entering the grounds is that of their unfinished condition. It is a lamentable characteristic of the American people that they do not allow themselves sufficient time for

the proper consummation and execution of a work of this kind. What is true of the Atlanta Exposition was equally true of those held at Philadelphia and Chicago. None of them were even presentable on the opening day, and for weeks afterward there was confusion on every hand, and hurried work was the result. In this respect it would be well for us to take a lesson from the French, who began their preparations for the Exposition of 1900 in 1893, and actually settled on the time a year before that: while for the great Chicago Exposition nothing was really done until 1891. This may be taken to demonstrate that we are more active than others, and do not require so long a time; but the question may well be asked whether, with our hurried exertions and rapid adoption of plans that are not fully matured, we turn out as finished a product and one that is as pleasing to our visitors as do those people who spend more time in deliberation and do not act until every phase of the subject has been carefully considered.

The Atlanta Exposition is, of course, comparatively small, but it is well worth visiting even at the expense of some minor comforts that more forethought on the part of the management could have readily provided.

THE STORAGE BATTERY FOR CENTRAL STATIONS.*

By Arthur E. Childs.

The object of this paper is to bring before the Institute the main facts and considerations concerning the application of accumulators in electric generating stations both for light and power. The fact that storage batteries have reached a point of high efficiency and low cost of maintenance has stirred up engineers in this country to consider the application of storage batteries to their own plants, and thus the accumulator has assumed great importance at the present time, especially as power and light stations are so far developed that further increase in generating capacity means large additional expenditure, and in a great many cases the rebuilding of the entire plant.

Realizing, therefore, that storage batteries are eminently practical as auxiliaries, and that their utility and value are acknowledged throughout Europe, it is not surprising that engineers and managers in this country are inquiring about them with the end in view of securing the full measure of their advantages and benefits. In England and on the Continent, storage batteries have been used in central stations for more than five years, and the success of their application has brought about a great change of feeling regarding them; and the respect with which they are now regarded is an ample indication of the value they have been to managers in the operation of their stations.

It is an acknowledged fact that the great variations and fluctuations of the load on power circuits, especially those power circuits supplying trolley lines, are among the greatest difficulties which engineers have to contend against, and any appliances which will aid them to arrive at a satisfactory running of their station is looked upon with favor by them. It is only in the ranks of those short-sighted engineers, where ignorance and prejudice are the rule rather than the exception, that there are found men who will refuse to consider the storage battery as an auxiliary.

In this paper the term "variation" is used to designate the change of current induced by the adding of lights on to a lighting station, or the cars or motors on to a power station. The term "fluctuation" is used to indicate those rapid and necessary changes of current taking place on the outside line, due to stopping or starting of cars or throwing on or off of stationary motors. Although they may be thus differentiated, they bear a certain relation to each other, and in applying a storage battery a study of the conditions will quickly indicate the type of battery which will be more favorable in each case. By the "type" of battery is meant the slow discharge battery for a long period of service, or the rapid discharge battery for a few hours, or even less time of discharge.

In the lighting station, if we bear in mind the usual form of curve, it will be remembered that the instantaneous changes of current are minute and almost imperceptible compared with the steady increase or diminution of the total current of the station. Comparing the lighting curve with the usual form of power station curve, it will be noticed that the instantaneous changes of current are enormous compared with that in the lighting station curve. There is a similarity in the two curves in the fact that at certain hours of the day more cars are operated than at other hours, thus producing a general rise in the level of the power curve corresponding to throwing on of a number of lights in the lighting curve.

It is not the purpose of this paper to discuss the characteristics of the two curves, but to consider in a general way the application of storage batteries to the wiping out of the fluctuations and variations as they come upon the dynamos and engines. The introduction of a storage battery into a central station acts in a certain sense as a buffer between the external load and the dynamos, taking the shock of the variations without throwing the same on the engines. In this regard they have the effect of reducing the average percentage variation in load on the dynamo from a large amount to a very small one, making the operation of the machines more efficient. In fact, a storage battery acts as a regulator in this instance, maintaining as it does a constant voltage at the switchboard. This introduces the question of the efficiency of engines with varying loads; and, leaving out of account the reports by engine builders, who are naturally interested parties, it is a fact that not many extended and careful investigations of efficiency under varying loads have been carried out. Professor W. C. Unwin, of the Central Institution, at South Kensington, has shown, however, that a decrease of mechanical efficiency has a serious effect on the economy of working with a variable load, and with a load varying from 100 per cent. to 25 per cent., the efficiency decreases from 85 per cent. to 40 per cent.

As applied to power stations, and especially where water power is used, storage batteries are almost indispensable. The writer knows of several plants where the successful maintenance of a constant voltage on the machines is dependent upon the fact that an attendant sits by the governors of the wheels, and regulates them by hand, as the inertia of the water, even when the best water-wheel governor that has ever been produced is employed, is too great to allow the turbines to pick up or throw off the load with anything like the quickness with which it is thrown on or off by the outside circuit. The stations in mind are not small stations, as might be supposed at first thought, but are stations where several thousand H.P. and over are generated at certain hours of the day; and it is surprising that engineers of intelligence, who are usually quick to perceive the advantages of new applications, are still allowing their prejudices to prevent them from investigating the merits and value of accumulators as regulating governors in their stations.

In the application of storage batteries to the power station of a trolley system, it is not unusual to find the variation in load as much as 50 per cent below the average H.P., and even as great as 200 per cent. above the mean load. These enormous fluctuations take place in the course of a few minutes, and are an expense to the railroad companies in at least three ways. In the first instance, they require the use of a dynamo capacity very much in excess of that required where the station is operated at a constant load. In the second instance, these fluctuations reduce the life of the machinery of the station, producing a very large depreciation account. In the third instance, the efficiency of the generating plant is very much reduced, as pointed out in a previous paragraph. It has been figured out in a number of instances that could the steam be utilized in a proper manner in the engines driving the dynamos, that at least 40 per cent. more work could be obtained from it.

When considering the application of storage batteries to illuminating plants, it is found that their value is equally as great as in the case of power stations, as the charging of the battery can be done while the plant is operating at light loads, thus making use of the power of their machines to great advantage. At the period of heavy load, the battery is able to take care of the peak of the load, and also to operate the lights during that period of the 24 hours when few lights are being supplied from the station.

The value of an accumulator plant attached to an illuminating station has been thoroughly demonstrated by the New York Edison Illuminating Company, and the Edison Illuminating Company of Boston, and recently in the plant of the Lawrence Gas Company, Lawrence, Mass. In the latter case the battery is used in connection with their Edison three-wire system, and is used in the regular way of carrying the peak of the load during the busy hours of lighting. A secondary use of this particular battery is that at noon, when the large mills on the Merrimac at Lawrence shut down, they back up the water into the river above and entirely cut off the supply to the wheels of the gas company (for some 25 or 30 minutes), which are thus unable to operate the machines furnishing light and power until the overflow of the water which is dammed back comes down and allows the station to be oper-

* Paper read at the American Institute of Electrical Engineers.

ated. This short period of absence of water is taken care of by the storage battery plant.

The storage battery can also be used as a valuable adjunct to both power and lighting stations at points in their systems where it is difficult to maintain the voltage at periods of heavy load. In these cases the feeders are usually not sufficient to carry the whole current direct from the station. But during the periods of small load the feeders can be utilized up to their maximum allowable drop in potential to charge battery sub-stations placed at these weak points. When the load at such points becomes greater than the capacity of the feeder, the battery comes into play and carries the load in connection with the station supply at that point, thus maintaining the voltage and doing satisfactory and valuable service. There must be hundreds of street railroads in this country that have just such weak points, and it will only be in accordance with the established progressive character of American street railway and lighting engineers, to investigate the value to them of a storage battery, as soon as it has been brought thoroughly to their notice. This cannot but result in a widely extended use of the storage batteries for this purpose; and the expectations of those interested in storage batteries would not be exceeded if half the street railroads and direct current lighting plants in this country and Canada should adopt within the next few years storage batteries either at their central stations or at sub-stations, the more especially as they can now obtain storage batteries which are thoroughly reliable, and which can be installed under a guarantee.

The extent to which storage batteries have been used in England and on the Continent is very great; and it will surprise many engineers in this country to know that there are more than 20 lighting stations and several thousand isolated plants in Great Britain alone, using storage batteries. Further than this, there are in Germany 5,000 isolated plants and 15 railway power plants using storage batteries. In fact, 80 per cent. of all the central stations in Germany and Austria are equipped with storage batteries. In addition to the above, there are many stations in France, Italy, Holland, Belgium, Sweden, Norway, Denmark, and Spain, and two or three in Switzerland.

A survey of the progress which storage batteries have made in European countries, indicates no very great change in the principles of construction, but the results seem to be rather due to a thorough analysis and appreciation of the requirements of each case. This has resulted in a proper use of batteries and a correct recognition of the limitations of their usefulness. This fact alone has contributed largely to their successful application. The great difficulty in this country has been that engineers have not recognized a proper limit to the usefulness of a battery, but have, in many cases, far exceeded their specified limitations, and in this way have injured the batteries and cast discredit on them. It would be just as reasonable to overwork an engine until injured or worn out, and then declare that all engines were useless and expensive mechanical contrivances.

One point which has contributed largely toward the success of storage batteries in Europe, is the fact that engineers have endeavored to obtain long life and high efficiency even at the expense of increased first cost, and instead of attempting to obtain a large output per pound of element, they have limited themselves to a reasonable number of ampère-hours per pound. The result of this has been that the batteries in use in Europe have shown great endurance and solidity. The experience, however, which has been obtained with many American batteries has not been so promising as on the Continent, owing to the lack of proper appreciation of them. It would be greatly to the advantage of American engineers if they would follow the lines laid down by their European *confrères;* and if, instead of waiting for some marvellous development in the manufacture of storage batteries, they should make use of the existing high class and efficient batteries which are now offered to the public, and by using them in a reasonable manner they would obtain valuable and even remarkable results.

Great progress has recently been made in manufacturing large batteries which have a capacity large enough to take care of the needs of central lighting and power stations, and engineers need no longer complain that they are unable to get the large cells which they require. In fact, manufacturers can produce cells having almost any given capacity.

Considering the efficiency of a storage battery, the factors which tend to reduce it are due to a loss in voltage and in the quantity of current. These losses, however, are not so serious as they have been in the past, and manufacturers are at present able to guarantee a very high efficiency. In cells which were submitted to Professor H. L. Callender, an ampère efficiency of 96.1 per cent. was recorded, the watt efficiency being 84 per cent. In certain instances, however, known to the writer, these efficiencies have been slightly exceeded, and complaints from central station managers that they cannot obtain efficient cells are now groundless, as with the efficiencies named, an eminently satisfactory service can be obtained. It must be borne in mind that a loss of 16 per cent., or even 20 per cent., in the efficiency of the battery does not mean the loss of the same percentage in the output of the station, as the battery usually supplies, approximately, or even less, of the whole output in watt-hours, and it is, therefore, from that fraction of the whole output that the loss in the battery must be deducted.

In the matter of cost of maintenance of a storage battery outfit, it is now usual for the manufacturer to guarantee a fixed annual percentage. This percentage varies from 10 per cent. in small plants to a smaller percentage in large plants, depending, of course, on the conditions of operation and the use to be made of the battery, a study of which will soon determine what percentage can be guaranteed. In first-class plants well installed and operated by careful engineers, the cost of maintenance can be reduced to the vicinity of 3.5 or 4 per cent. It is customary for the manufacturers to enter into a contract, in the case of large plants, guaranteeing that the cost of maintenance shall not exceed a certain percentage per annum for the period of contract. This can be carried out in two ways. Either the lighting or railroad company can pay the manufacturer the percentage specified, every year, and the manufacturer will inspect and keep the battery in first-class condition; or the company employing the batteries can inspect and order renewals themselves, in which case should the cost of maintenance exceed the percentage guaranteed, the manufacturer will not charge more than the specified amount. This is an exception rather than the rule, however, as the cost of maintenance is usually somewhat lower than that specified by the manufacturers, so that the company owning the battery is the gainer by the difference in percentage. By a thorough attention to details, both large and small, the percentage can be kept down to a very low figure; and it is to be regretted that the practice of engineers which prevails in Europe, of treating the battery with care and consideration, does not seem to exist among the engineers of this country, to the detriment of their own lighting or railroad plants, which would otherwise be able to utilize batteries in an efficient manner.

It must not be assumed from the above that storage batteries require an inordinate amount of care and trouble. On the contrary, they do not require either expense or great care. All that is demanded is regular and systematic attention on the part of those having them in charge. When such care is exercised, it is found that batteries perform a very valuable service, and largely reduce the operating expenses of the station—in many cases as much as 30 to 35 per cent. This reduction in operating expenses is, of course, due to the saving in cost of coal consumed, a saving which could not otherwise be obtained. Where water power is employed, a storage battery enables the water-wheels to be operated for 24 hours, storing current while the station output is reduced to a minimum, and aiding the station during the busy hours of the day. In many cases this practically doubles the output of the station without increasing the cost of installation to a corresponding amount. In fact, in many cases where water power is used it would be impossible to double the power of a station, as there would not be enough water at hand to give double the power. This is especially true in those sections of the country where the power of small streams has been utilized and where the flow of water is continuous but not very great. In addition to a storage battery acting as a receiver for storing the current while the station is not giving a large output, it also maintains, during the operation of the station, a perfectly uniform voltage, which would not be obtained with the varying load direct upon the water-wheels, on account of the difficulty in governing previously mentioned.

When an entirely new power plant is to be built, there is no doubt that by adopting the storage battery in the first instance, the initial cost of installation will be less than for the plant not using storage batteries, and the cost of operation of the station will certainly be very much reduced when the station uses storage batteries. In the case of existing plants which have to be extended, it has been proved that a kilowatt-hour capacity can be added more cheaply to the station by the addition of storage batteries than by the addition of generating machinery; while, of course, the cost of operation is much reduced.

Referring to the primary cost of storage batteries, the cost per kilowatt-hour output is relatively greater for small cells than for large ones, since the cost of manufacture is reduced per kilowatt-hour in the larger sizes, whereas the jars and tanks which are used to hold elements do not decrease very

much with the decrease in size of the elements. The cost of shipment and erection are, of course, slightly less per kilowatt-hour with the larger sizes than with the smaller ones, and on the whole the cost per kilowatt-hour with the larger cells is less than with the smaller sizes. It is stated by the Electric Storage Battery Company that they are now installing large plants of the Tudor type at a cost per kilowatt-hour of about $37 to $40, which cost, it is understood, can be reduced in the larger stations. The question of cost, however, is one which must be studied out in each case where it is proposed to install storage batteries, and a consideration of the cost of installation of storage batteries with their attendant reduction in operating expenses will very soon bring to the mind of purchasers that it is cheaper to invest in accumulators than to invest in additional boilers, engines, and dynamos.

As previously stated, it has been the object of this paper to bring before the Institute the general facts and considerations relating to the installation of storage batteries as auxiliaries to power and lighting plants. Lengthy descriptions of plants already installed have been avoided, and those interested are referred to the published descriptions which are constantly appearing in the technical journals.

THE STORAGE BATTERY OR THE GAS-ENGINE AS AN AUXILIARY.*

By Nelson W. Perry.

Whether it is economical or not to equip a central station with an auxiliary storage battery plant is a question which must be decided separately for each particular installation. Generally speaking, the question will be decided by the character of the load line—a broad topped curve being the most unfavorable, and a sharp peak the most favorable to storage battery economy. Again, a station having a very light day load may use the battery to good advantage even though its night load may present a broad topped aspect.

Aside from purely economic reasons, convenience may be controlling, so that it is impossible to state unless all the conditions are known whether the storage battery is advisable or not.

The price of the battery is an important element, of course, but less so than popularly supposed, for the space which it occupies and the cost of maintenance may largely overbalance any gain in first cost over the cost of the extra boiler, engine, and dynamo.

In regard to the cost of maintenance, manufacturers are willing to guarantee that it will not exceed 10 per cent. per annum, but it is well to understand just what this 10 per cent. means. It means, in the first place, that if you put in all the battery power that the manufacturer recommends, and take care of the battery exactly as he says, then the guarantee holds good. Under such conditions the manufacturer is undoubtedly safe, but if we install a plant under these conditions we are pretty sure to find that the economy in first cost of the battery over engine and dynamo has entirely disappeared.

Then it is well to understand beforehand what the 10 per cent. means—10 per cent. of what? The public are given to believe that this means 10 per cent. of the *cost price* of the batteries and the statement has been freely made that this is what it means.

Some time ago I had occasion to inform myself accurately on this subject, and to this end entered into quite a correspondence with the president of the leading storage battery company of this country. As regards the guarantee, he wrote me under date of June 18, 1894, as follows:

"We send you by to-day's mail our illustrated catalogue, and would especially call your attention to the question of maintenance as contained on page 11. We undertake, in these cases, to provide renewals when renewals are required, at a specific price with a guarantee that this will not be required sufficiently frequent (*sic*) to exceed an average of 10 per cent. per annum. We have every reason to believe from our experience so far that the actual cost of maintenance when the batteries are used at normal rates will not exceed 5 per cent."

Turning to page 11 to see what this meant, I found the following:

"This company is prepared to undertake maintenance contracts according to a scheduled rate of charges, for periods up to 10 years or longer, under which they will guarantee that the total amount paid for renewals during the term of the contract shall not exceed 10 per cent. per annum on the *catalogue* price of the cells specified in the contract. . . . *In all cases of renewal by* contract the old material becomes the property of the company, *and must be returned to their works free of charge for carriage or packing.*"

[The italics are mine.]

Since the regular trade discount at that time was 20 per cent. of the catalogue price, and a further discount was offered which made the cost of the batteries comparable with that of an engine and dynamo, the guarantee assumed a very different aspect from that which it bore on its surface. When to this was added the cost of packing and carriage back to the factory, it ceased to be an attractive guarantee, and my calculations showed that in many cases where the storage battery might be recommended, if the guarantee was what it appeared to be, it would not be economical under the guarantee as it actually was.

This petty deception, together with the application of the battery to uses for which it is not adapted, has brought it into an ill repute from which it will take a long time to recover, and for which the manufacturer has only himself to blame.

As before indicated, there are some situations in which either convenience or extreme steadiness of current may be controlling in deciding the question of the use or not of storage batteries. But where the question is one purely of economy, I would not myself recommend their use under any circumstances, simply because there is a still more economical method at hand. I refer to the gas-engine. Even if it were necessary to use illuminating gas from the street mains it would be more economical (considering space and other factors), to take the peak of the load with a gas-engine than to install a battery for this purpose. In this case there would be no standby losses, and the engine would be ready at a moment's notice to be thrown into service.

It is a fact that has been amply demonstrated by others as well as myself, that a given number of lights can be produced with half the gas burned in a gas-engine that is required to produce them in ordinary burners. The mechanical efficiency of the gas engine is not quite so high as that of large compound condensing steam-engines, rarely ever exceeding 83 to 85 per cent., while the latter may go to 90 per cent., but the total efficiency from fuel to the pulley of the gas-engine is about double that of the steam-engine—reaching 25 per cent. under favorable conditions, whereas with the steam-engine it rarely equals 12 per cent. So that with the gas-engine operating at anywhere near its full load, there would be a gain in efficiency, instead of a loss of, say, 20 per cent. where the battery was used.

As indicating the performance of a gas-engine using illuminating gas at various loads, I quote the following figures obtained from a test of a 12-H.P. (actual) gas-engine:

Actual H.P. developed.	Gas consumption (cub. ft.) each actual H.P.
12	15
11	15.3
10	15.5
9	16
8	16.5
7	17
6	18
5	19
4	21
3	26
2	30
1	48

These figures are somewhat better than would be obtained in practice, but go to show that the gas-engine compares favorably at light loads with the steam engine under similar conditions.

Thus far I have spoken only of illuminating gas, but the power may be much more cheaply generated by using a fuel gas.

The cost of producers or generators comes to about $11 per H.P. capacity—considerably less than the cheapest boiler, and an idea of the space required may be gained from a statement of Mr. J. Emerson Dawson, who in estimating for a plant of 400 K.W. capacity says that if the gas plant is all on one level it would occupy a ground space of 27 ft. × 54 ft., but, if necessary, all except the gas holder can be placed under or over the engine-room. His estimate for such a plant is, including erection, foundations, and ash-pit for generators $5,500, or $10.38 per H.P.

These fuel-gas generators can utilize advantageously the poorest grades of fuel, and produce from the better grades of anthracite about 160,000 cub. ft. of gas of a calorific value, equal to one-quarter that of 16 C.P. illuminating gas, per ton of coal.

* Paper read at the American Institute of Electrical Engineers.

As to the standby losses of the gas producers, this has been very carefully determined in a number of cases. As an illustration I will cite a single case—by no means the best on record.

At Openshaw a generator which supplied gas for from 250 to 300 I.H.P. was shut down for 41 hours, and the fuel consumption during this time was but 3.9 lbs. per hour, or about 1 per cent. When we compare this with the standby losses of the steam boiler, which is estimated by Professor Kennedy at 10 per cent. of the total consumption in all the boilers, we see how insignificant it is.

A situation usually considered peculiarly adapted to the storage battery is in subordinate or outlying stations where they are charged during the daytime from the central station and act as centres of supply during the night-time.

But gas can much more economically be distributed to these stations than can the electric current, for Mr. Denny Lane* has shown that with ordinary 16 C.P. gas, 3,000 H.P. can be sent a mile for an expenditure of 1 H.P., or one-thirtieth of 1 per cent. of the power conveyed.

My own calculations show that a 6-in. pipe will deliver 6,000 cub. ft. of gas per hour at a distance of 10,500 ft. under 4 in. of water pressure. If this be 16 C.P. gas, allowing 25 cub. ft. per H.P. hour, this quantity represents 240 H.P.

Cast-iron pipe, 6 in. in diameter, having a thickness of ½ in., weighs 31.9 lbs. per foot. The total weight of this 2 miles (nearly) of pipe will therefore be 334,950 lbs. This would be equivalent in conductivity to about 41,869 lbs. of copper. But 4 miles of copper weighing 41,869 lbs. would be equivalent to about four No. 000 B. & S. wires, which would have a resistance for the 4 miles of 0.325 ohms. If the charging current were transmitted at 220 volts, there would be required a current of 848 ampères; but a wire having a resistance of .325 ohms will only deliver under a pressure of 220 volts 220 ÷ .325 = 677 ampères, there would, therefore, be required five No. 000 B. & S. wires to deliver this energy, and the weight of this would be 53,540 lbs.

If the distribution took place at 1,000 volts, the ampères required would be approximately 180. To deliver this at the same distance with a loss of 10 per cent. would require 6,264 lbs. copper, and to deliver it at 1 per cent. loss would require 62,642 lbs., which would cost far more than the pipe and still give less efficient transmission.

I think it would be very easy to prove that he gas-engine with fuel gas would prove a much more economical auxiliary to the central station for taking the peak of the load and the loads amounting to fractions of a unit, than the storage battery, and when we consider the efficiency of transmission of energy in the form of gas, which will permit of the location of the gas generators where land is cheap and fuel easily procured, it seems to me that the plan must commend itself to electrical engineers.

Unfortunately the gas-engine business in this country seems to be in the hands of parties totally incompetent to handle it properly, as every one knows who has ever had occasion to seek information from them.

It is probably not too much to say that every attempt thus far made in this country to adapt the gas-engine to electric lighting has proved a failure. Our own manufacturers either do not know what their engines are capable of doing, or else they are afraid to make public what they will do. I believe there is not a single manufacturer who has a printed price-list, and my own experience, and that of others whom I know, has been that it is impossible to get prices quoted until the manufacturer or his agent has been thoroughly satisfied of the exact purpose for which the quotations are desired. Information of any kind is almost impossible to get; and guarantees of performance, when given, are worthless. To such an extent is this true, that nearly all if not all the recent large orders for gas-engines have gone abroad, where the business is conducted on business principles.

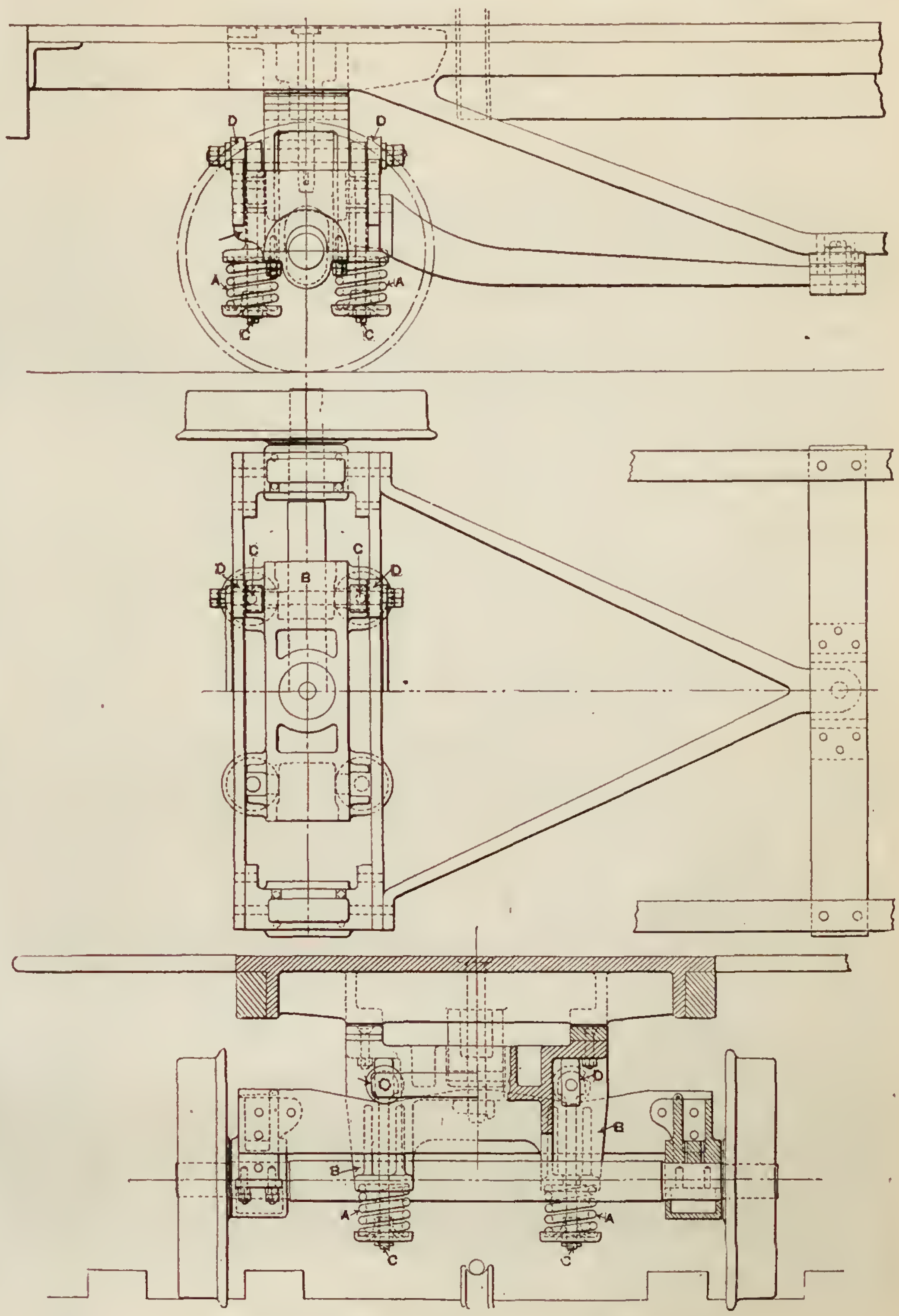
In England, Germany, and France the gas-engine has come into extensive use in isolated lighting, and already has been adopted with satisfactory results in several central stations of considerable size.

When the business is properly handled in this country we may expect to see the gas-engine make its way rapidly in the lighting industry here also, for it has merits which need only be known to be appreciated.

* *Electrician*, October 9, 1891.

PONY TRUCK, BY H. K. PORTER & CO.

In our issue for October we published an illustrated descrip-



PONY TRUCK, MADE BY H. K. PORTER & CO.

tion of the switching locomotives that have recently been built for the New York and Brooklyn Bridge by H. K. Porter & Co., of Pittsburgh, Pa. In this description we referred to the peculiar construction of the pony truck, wherein there are some rollers that, whenever the truck is turned out of align ment, are made to move up an incline and thus maintain a constant tendency to bring the truck back into its central position. We are now enabled to present a detailed drawing of the truck from which a clearer idea of the construction will be obtained than would be possible from a mere verbal description.

The weight of the rear end of the locomotive is put upon the springs *A A* through the casting *B B*. The springs are supported by the hangers *C C* that run down through the centre of the spring and have an eye at the upper end for a bearing on the axle of the sheaves *D D*. When the truck is in its central position these sheaves rest in the bottom of the inclines cut in the truck transom and hold it steadily in place. When the engine is rounding a curve and the wheels turn from the true central alignment the sheaves are caused to roll up the inclines.

In doing this they lift the hangers and exert a pull on the bottom of the springs, not necessarily lifting the engine, but exerting a force whose reaction tends to draw the truck back into position.

In other respects the truck is very simple in construction, and is in reality a mere skeleton. It is interesting to note the arrangement of the parts, which are so disposed as to give the proper clearance for the cable over which they are compelled to run, and which is shown in position between the rails of the end elevation.

A CAPTIVE BALLOON AT THE CHAMPS DE MARS.

During the summer that has just passed one of the features of the exposition that was held on the Champs de Mars in Paris was a captive balloon that was built and exploited by Messrs. Godard, Sarcouf & Courty. The balloon had a cubic capacity of 105,950 cub. ft. It was kept inflated for 125 days, and during that period 12,800 passengers were carried, of whom 3,500 were women. At the end of that time a free ascension was made with a load of 15 people.

Referring to our engravings, the smallest (fig. 1) shows the balloon hauled down and fastened to its moorings. Fig. 2 shows the car with its load just as an ascension was about to take place, and fig. 3 is the reproduction of a photograph taken from over the side of the car and looking directly downward. The circle close to the bottom of the picture represents the anchorage of the balloon, and the anchor line is distinctly marked leading from the central pit. This photograph was taken from a height of 1,650 ft., and gives a very good idea of the destruction of perspective by altitude when the line of vision is vertical to the surface of the earth. The roofs of the houses are flattened out so that they seem flush with the ground, and the trees are mere blotches on the surface.

The balloon was controlled by a powerful windlass and cable, the former being driven by steam power and located in the pit beneath the car when the balloon was at its moorings, as shown in the engraving (fig. 2).

DESCRIPTION OF A LOCOMOTIVE DEPOT FOR THE ACCOMMODATION OF 180 ENGINES AND TENDERS.*

By W. G. Scott, M. Inst. C.E.

The total area of land comprised within the limits of the site chosen for the above depot is about 90 acres, of which 36 acres are at present being used for the purpose of the locomotive depot requirements, the larger remaining portion of the estate being reserved for future sidings, etc., for dealing with goods and mineral traffic. The whole area of land at present used had to be levelled, and the general nature of the ground peat and sand. The engine shed stands on a site occupying 17, 014 sq. yds., is 362 ft. long and 423 ft. wide. It contains 30 lines of rails, each capable of holding six locomotives, giving a total accommodation for 180 engines. In each road is constructed a longitudinal pit used for the purpose of the examination of, and slight repairs to, the machinery of the locomotives. These pits extend the whole length of the shed, with the exception of a distance of 10 ft. at each end, which is left as a passage across the shed. The pits are entered by the men by means of four steps at each end, and are sloping in transverse section at the bottom, the latter being 2 ft. 9 in. below rail level at the lowest point ; along one side is placed a cast-iron gutter of U pattern, in section, with wrought-iron perforated covers 12 in. wide. The bottom of the pits are paved with brindle brick on edge, laid on a bed of concrete 4 in. thick ; the side walls are built with 18-in. brick-work and faced with brindle brick, each carrying a longitudinal timber covered with sheet-iron 15 I. W. G. to which the rails are secured with screwed spikes, these rails being of Vignole's pattern and weighing 90 lbs. per yard.

The whole of the shed is laid on a foundation formed with Portland cement concrete in the proportion of 6 to 1 and 1 ft. 6 in. thick. The walls are built with common brick, faced with red Ruabon bricks laid in Flemish bond —panelled on the outside and limewashed on the inside, the floor being paved throughout with brindle brick on edge, laid on a bed of concrete.

The roof consists of a series of bays, the principals of which are of the queen post roof truss type, supported by the shed walls outside and on columns inside. The spans of the roofing vary between 41 ft. and 44 ft. with a pitch of about 30°, and having a clear headway of 16 ft. between the underside of the tie beam and the rail.

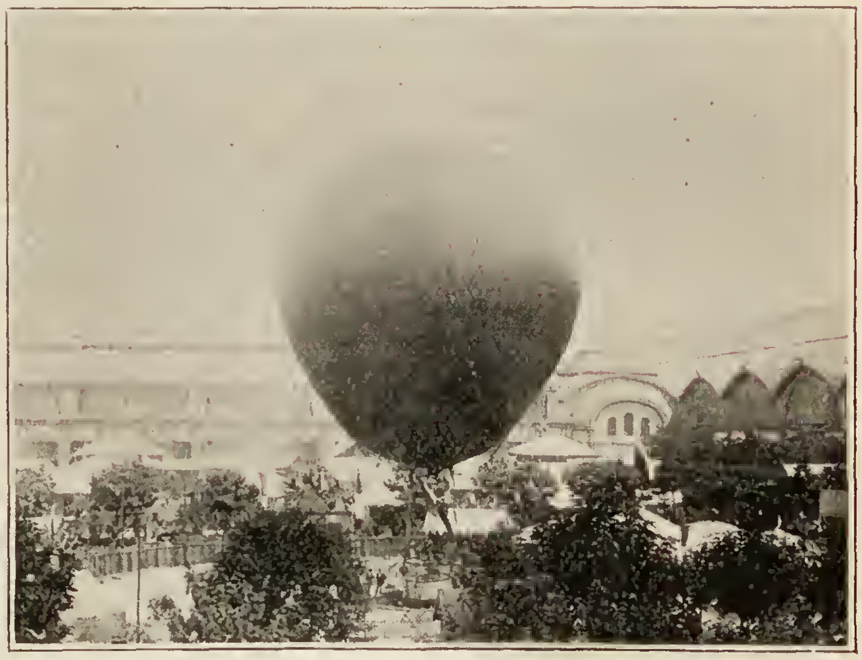


Fig. 1.—CAPTIVE BALLOON AT ITS MOORINGS.

The shed is lighted by day from the roof, by means of skylights, one set running the whole length of the shed on each side of each ridge, and 7 ft. wide, also intermediate lights are placed between the above and the valley gutters, each about 12 ft. × 6 ft. The remaining portion of the roof is covered with Velinhelli slates laid on 1-in. grooved and tongued boarding and spars. The cast-iron columns which carry the roof principals are 9 in. in diameter, having a base 12 in. in diameter, and are placed at intervals of 24 ft. centres ; they are connected with girders of lattice pattern 2 ft. 6 in. × 12 in. Over the centre of each locomotive road, and attached to the underside of the tie beams, is hung a smoke trough measuring 3 ft.

Fig. 2.—CAR OF CAPTIVE BALLOON READY FOR AN ASCENT.

* Paper read before the Liverpool Engineering Society.

6 in. below the tie beam and 3 ft. wide, ventilated at each 24 ft. by means of vertical shafts or flues 2 ft. 8 in. × 1 ft. 3 in., and covered with ½-in. wrought-iron curved plates supported by angle-irons. These shafts and the troughing carry away the smoke and steam from the locomotives, and at the same time provide perfect ventilation. The whole of the pits are drained into a 12-in. pipe running along and parallel to the front of the shed, this drain being connected to the main outfall sewer by an 18-in. pipe. The entrances to the shed can be closed by means of doors hung to cast-iron jambs, one to each line of rails, built and hung in two halves. In alternate spaces between the locomotive roads are placed, about each 50 ft., hydrants for flushing and washing out purposes, supplied from the water tanks by service pipes 4 in. in diameter.

On each side of the shed are erected two sets of buildings, which are used as a smithy, fitters shop, and mess room, and which are entered from the shed. These two blocks of buildings are each 127 ft. long and 18 ft. wide, the height to the underside of the tie beams being 17 ft. The walls are of 14-in. panelled brick-work.

Each smithy contains several hearths. The mess-room is equipped with table and seating accommodation, also sinks and water supply.

The whole of the shed surrounding buildings and yard are lighted by 2,000 gas jets.

At the east end of the shed, on the outside, are erected two buildings for carrying the water tanks, each 30 ft. high, to the underside of tank, the walls being constructed of 18-in. brickwork, the floor of the inside of this building being paved with brindle brick on edge laid on a bed of concrete. The tanks are constructed of cast-iron plates 6 ft. 3 in. deep by 50 ft. long and 27 ft. 6 in. wide, and will each contain 50,000 galls. of water, being supplied by mains 4 in. in diameter, the inlet being controlled by an equilibrium valve. The tanks are surmounted and surrounded by a handrail 3 ft. high, with a bracketed gallery 2 ft. wide, running entirely round the inside top edge of the tank for the purpose of inspection and repair.

The tanks rest upon cast-iron girders 2 ft. deep, the pressure on the sides is relieved by means of 1-in. raking tie rods in both directions.

Extending across the whole front of the shed and constructed on each road are ash-pits each 33 ft. long, 3 ft. 6 in. deep, with five steps at each end, and are similar in construction to those in the shed. The whole of the area in front of the shed is paved with brindle brick on edge.

Adjacent to these pits, and erected in such a position as to be capable of supplying two roads each, are fixed 10 water columns or cranes which are supplied from the tanks direct by means of 8-in. pipes.

Two sand furnaces are provided. The buildings used for this purpose are each 29 ft. long by 20 ft. wide, and 17 ft. to underside of the tie beam, paved with brindle brick on edge, and containing a furnace used for drying sand, also for lighting the fires of locomotives.

There are also two blocks of buildings used for the purpose of offices, stores and lavatories, each block being 105 ft. long and 27 ft. wide; they are built with 12-in. brick walls with 2-in. cavities, having an internal clear height of 12 ft. The office floors consist of 1½-in. tongued and grooved boards laid on 7-in. × 2½ in. joists, at 16-in. centres. The stores are paved with brindle bricks on edge, and the floors of the lavatories with concrete.

Two sets of latrines, with accommodation for 15 persons each, and two blocks of water closets are provided.

Three 50 ft. engine turntables are provided. The circular walls surrounding the pits are built in brick-work with Yorkshire stone coping. The centres of the tables are placed on stones 6 ft. 6 in. × 6 ft. 6 in. × 3 ft., laid on a bed of cement concrete resting on sills and supported on 9-in. circular larch piles driven about 18 ft. down into the clay substratum. The movable platform and rails are carried on two iron girders, which are supported upon a centre steel pivot; the girders are connected by ties and trolley castings at each end, and travel on a circular rail path placed in the bottom of the pit.

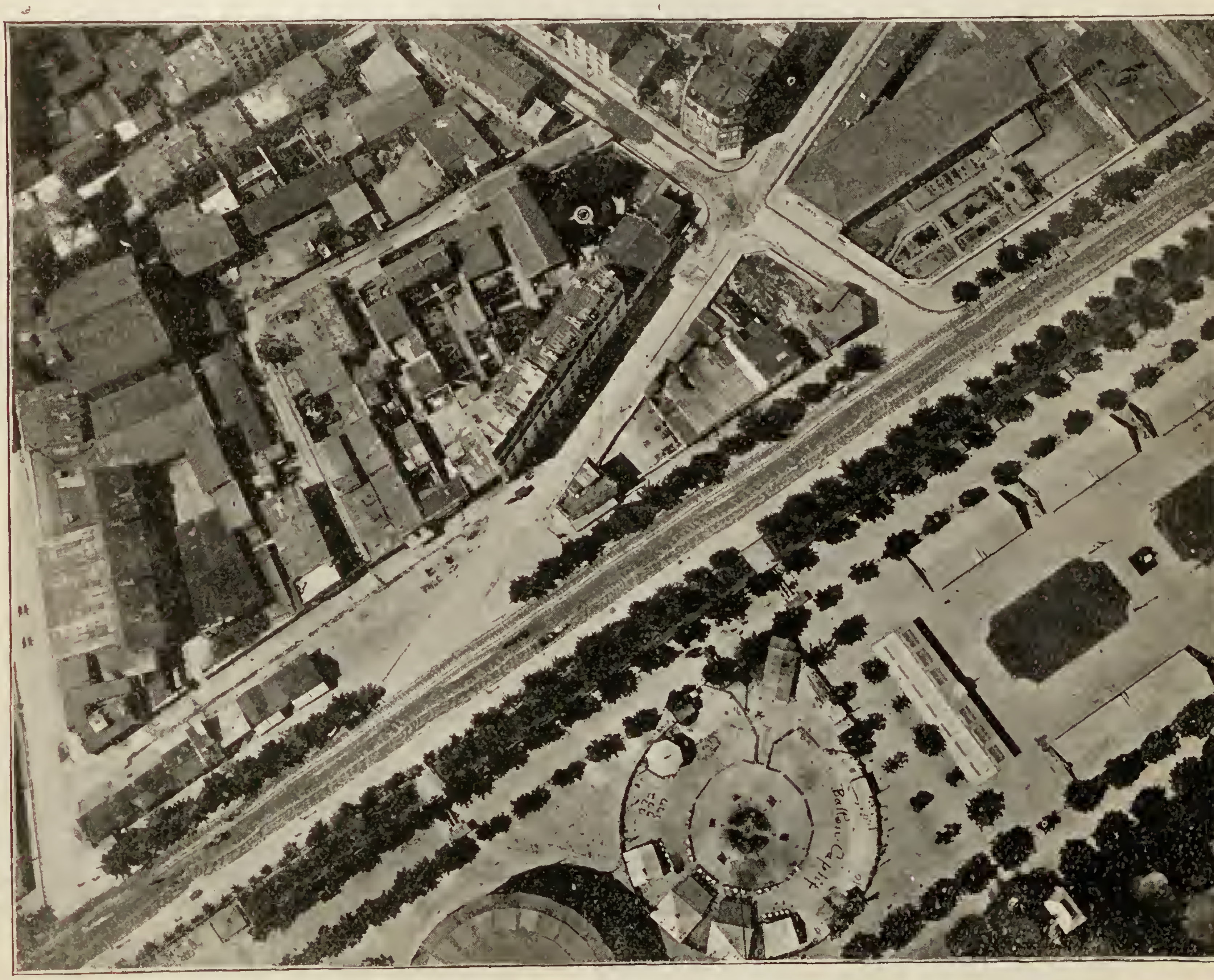


Fig. 3.—View from the Captive Balloon at the Champs de Mars from a Height of 1,650 ft.

To admit of examinations and light repairs to locomotives, a method of lifting is adopted by means of a hoist, or shear legs; these hoists consist of four wrought-iron uprights, two latticed together; these are fixed at bottom in triangular form on bedstones; the above uprights are in section composed of two channel irons connected by plates; the three uprights are riveted together at the top, and support the tackle for lifting engines; the power is obtained by a winding gear fixed to the lattice supports, and is capable of lifting a load of 35 tons.

To carry out the coaling operations of the engines stabled at this depot there are provided two sheds. Within the sheds are platforms at a height of 11 ft. 6 in. above rail level on either side, and the coal is delivered to the platforms by trucks running up an approach to the sheds at a gradient of 1 in 25. The level at which the coals are thus delivered renders it possible to supply locomotives standing on sidings along each side of the sheds. The length of each shed is 100 ft., and the width of each platform 18 ft. 6 in. The coal is placed on the platforms from the railway wagons standing on the two centre roads of the shed, and is discharged into the tender of the locomotives by tubs on wheels and emptied by means of tumblers or balanced loading-flaps. The length of the inclined approach to the high level is about 250 ft., with a piece of level road 60 ft. in length in front and 60 ft. beyond the end of the coaling shed.

The water supply is derived from the corporation mains, and is conveyed to the depot by means of pipes 6 in. in diameter for a distance of 600 yds.

The permanent way, having a total length of about 7¼ miles, is laid on creosoted sleepers 9 ft. long, 10 in. × 5 in., and is ballasted to an average depth of 18 in. below rail level. The rails are of a bull-head type in 30-ft. lengths, 85 lbs. per yard, and secured to sleepers by chairs spiked and keyed in position.

To connect the engine shed with the main line a double junction with the main line and a branch had to be constructed, also a new signal cabin erected with interlocking apparatus and signals complete.

INGERSOLL DRILLS ON THE CHICAGO DRAINAGE CANAL.

A representative of the American Engineer recently made a visit to Lockport, on the line of the Chicago Drainage Canal, with a representative of the Ingersoll-Sergeant Drill Company for the purpose of inspecting the air compressors and drills at work on Sections 14 and 15, supplied by the Ingersoll Sergeant Company.

Upon Section 14, which is operated by contractors Smith & Eastman, and 1 mile in length, there are two compressors, one 16 × 24 in. straight line, and one 20 × 36 in. duplex Corliss, of 70 H.P. and 330 H.P. respectively.

The air main is of 8-in. wrought iron pipe laid upon the surface, and with occasional offsets to provide for expansion and contraction. This pipe serves 19 drills with air at a pressure of about 80 lbs. per square inch. To prevent the formation of ice at the exhaust openings of the drills, the air is warmed before entering the drills by building a small fire on each side of the service pipe. This also serves, in a slight degree, to restore power lost owing to the cooling and consequent contraction of the air between the compressor and the drill.

Upon this section seven Ingersoll-Sergeant channellers are at work. They are operated by steam, each channeller having its own 30-H.P. vertical boiler. The average work of each channeller for the past season has been about 110 sq. ft. per day of 10 hours. The maximum work, near the surface, 310 sq. ft. In plan the shape of the channelling cutter is a Z about 2 × 6 in. over all.

The average work of the drills is about 82 lineal feet of drill hole, and running from 70 ft. to 100 ft. per day of 10 hours. With these drills and channellers the contractors were enabled to excavate, and they deposited in the spoil bank in a single month 86,000 cub. yds. of solid rock.

The excavated material was transferred to the spoil bank by means of four double boom derricks designed by Mr. Geraldson, the sub-contractor, and by two St. Paul derricks built by the American Hoist & Derrick Company, of St. Paul, Minn.

Upon Section 15 contractors Wright, Meysenburg, Sinclair and Carry, when working a full force of men, employed 10 drills operated by air, and four drills run by steam, as well as three channellers. These, as well as the compressor, were furnished by the Ingersoll-Sergeant Company. The compressor is of the duplex Corliss type 16 × 36 in.

This plant enabled the contractors to excavate 53,000 cub. yds. of solid rock in a single month. The shattered rock is loaded on dump cars by two Bucyrus steam shovels, which handle this rough material in a manner that has to be seen to be realized.

The dump cars are hauled to the spoil bank by locomotives. Mr. Sinclair, one of the contractors, states that nothing short of Swedish iron will stand in the 1-in. and the 1¼ in. chains that operate the motions of the shovels. Steel was tried, but had to be abandoned. The fingers on the buckets are made of charcoal iron tipped with steel. During the past summer there were at work on the line of the Drainage Canal seven Ingersoll-Sergeant air compressors, and located as below:

Section	1, 1 compressor		118 H.P.
"	8, 1	"	330 "
"	12, 2	" each	150 "
"	14, 1	"	330 "
"	14, 1	"	70 "
"	15, 1	"	207 "

The compressors are thoroughly explained in Catalogue No. 50 of the Ingersoll-Sergeant Drill Company, on pages 30–61 inclusive. One of the main features is the piston inlet for the air, with large valve area and minimum of clearance. The discharge valves only being in the cylinder heads, make it possible to water jacket a major portion of the heads, as well as the body of the cylinder.

The unloading device as a regulator for the pressure is well devised and effective.

The compressors are thoroughly explained in Catalogue No. 50 published by the Ingersoll-Sergeant Drill Company on pages 30–61 inclusive, a copy of which has been received. The various forms of compressors which this company manufacture are very fully illustrated and described in their catalogue, and much interesting and valuable information relating to the subject is given, thus illustrating again the truth of the observation, repeatedly made in these pages, that the best technical literature relating to some subjects is often to be found in trade catalogues. The compressors made by this company may be divided into two general types, the first, which they call their "duplex cross compound condensing Corliss air compressor," and the second, their "straight-line air compressor." The first consists of a two-cylinder compound Corliss engine, the pistons being connected in the usual way to cranks, at right angles to each other, on a main shaft. The rods of these pistons are extended through what on a locomotive would be called the front cylinder-head, and are connected to pistons in air cylinders placed some distance ahead of the steam cylinders. The valve gear is of the Corliss type.

The "straight-line compressor" has a single steam and air cylinder attached to a common frame and placed a short distance apart. The piston rod extends from one cylinder through to the other, and is connected to the two pistons. Midway between the cylinders is a wide cross with bearings on its end, to which a pair of connecting-rods are attached which are coupled to a crank shaft ahead of the steam cylinder. The whole arrangement is very compact and is self-contained. The valve gear of the steam cylinder is of the Meyer type.

The Ingersoll drills and channelling machines are very fully illustrated and described in Catalogue No. 40, referred to above, from which much valuable information may be obtained. We expect to give some illustrations of these machines in a future number.

DEATH OF MR. PATRICK STIRLING.

The English papers have announced the death of this well-known locomotive superintendent of the Great Northern Railway Company. He was born in Kilmarnock, in June, 1820, and was the son of Rev. R. Stirling, D.D. The son commenced his engineering career by an apprenticeship under his uncle in the Dundee Foundry. After advancing step by step in various positions, he was appointed in 1866 to the position he held at the time of his death. He was noted in that capacity in his own country not only for the ability he showed in the management of his department, but for the fact that he advocated the outside cylinder type of locomotive long after it had been abandoned by most locomotive engineers for express service in England and Scotland. Of this practice *Engineering* says: "The type of locomotive to which Mr. Stirling was loyal to the close was the large single driving-wheel engine, with outside cylinders and a bogie at the leading end." He was a man very much respected by all who knew him, and, as our contemporary says, "his friendship was most valued by those who knew him best."

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